10/052915 11/05/03

L Number	Hits	Search Text	DB	Time stamp
1	64	725/31.ccls. and (movie)	USPAT; US-PGPUB	2003/11/05 15:40
2	3	digital adj2 movie adj2 encrypt$4	USPAT; US-PGPUB	2003/11/05 15:43
3	3	digit$5 adj2 movie adj2 encrypt$4	USPAT; US-PGPUB	2003/11/05 15:44
4	168	digit$5 same movie same encrypt$4	USPAT; US-PGPUB	2003/11/05 15:44
5	59	(digit$5 with movie with encrypt$4)	USPAT; US-PGPUB	2003/11/05 15:47
6	25	(digit$5 with (theater or theatre or cinema) with encrypt$4)	USPAT; US-PGPUB	2003/11/05 16:59
7	1	(strong near4 encrypt$4) same (weak near4 encrypt$4) and 725/$.ccls.	USPAT; US-PGPUB	2003/11/05 17:00
8	39	((first or primary or initial) near4 encrypt$4) same ((second$3) near4 encrypt$4) and 725/$.ccls.	USPAT; US-PGPUB	2003/11/05 17:03

10/05 2915

11/4/03

L Number	Hits	Search Text	DB	Time stamp
-	53	725/10.ccls.	USPAT; US-PGPUB	2003/11/04 15:05
-	33	725/$.ccls. and ((theatre or cinema or theater or auditorium) with network)	USPAT; US-PGPUB	2003/11/04 14:52
-	1	5801754.pn.	USPAT; US-PGPUB	2003/11/04 11:25
-	8	5801754.URPN.	USPAT	2003/11/04 11:26
-	34	725/12.ccls.	USPAT; US-PGPUB	2003/11/04 13:48
-	22	725/11.ccls.	USPAT; US-PGPUB	2003/11/04 13:54
-	26	725/16.ccls.	USPAT; US-PGPUB	2003/11/04 14:06
-	91	725/24.ccls.	USPAT; US-PGPUB	2003/11/04 14:06
-	29	725/24.ccls. and (movie or cinema or theater or theatre)	USPAT; US-PGPUB	2003/11/04 14:06
-	12	725/$.ccls. and ((audience or viewer or moviegoer or "movie goer" or "movie-goer") with camera with (monitor$4 or watch$4 or survey$3))	USPAT; US-PGPUB	2003/11/04 14:59
-	2	725/10.ccls. and ((movie or cinema$8) same (camera or(video adj1 monitor$4)))	USPAT; US-PGPUB	2003/11/04 15:06
-	2	725/10.ccls. and ((movie or cinema$8 or theater or theatre) same (camera or(video adj1 monitor$4)))	USPAT; US-PGPUB	2003/11/04 15:06
-	8	5801754.URPN.	USPAT	2003/11/04 15:12
-	1	5835715.pn.	USPAT; US-PGPUB	2003/11/04 15:20
-	1	5,226,177.pn.	USPAT; US-PGPUB	2003/11/04 15:20
-	1	6356939.URPN.	USPAT	2003/11/04 15:27
-	1	"5412416".PN.	USPAT; US-PGPUB	2003/11/04 15:28
-	1	"5924039".PN.	USPAT; US-PGPUB	2003/11/04 15:28
-	1	"5924013".PN.	USPAT; US-PGPUB	2003/11/04 15:29
-	1	"5920626".PN.	USPAT; US-PGPUB	2003/11/04 15:29
-	1	"5828403".PN.	USPAT; US-PGPUB	2003/11/04 15:29
-	1	"5795046".PN.	USPAT; US-PGPUB	2003/11/04 15:29
-	1	"5729279".PN.	USPAT; US-PGPUB	2003/11/04 15:29

US005973722A

United States Patent [19]

Wakai et al.

[11] Patent Number: 5,973,722

[45] Date of Patent: Oct. 26, 1999

[54] **COMBINED DIGITAL AUDIO/VIDEO ON DEMAND AND BROADCAST DISTRIBUTION SYSTEM**

[75] Inventors: **Bruce Minoru Wakai**, Cypress; **Robert Troxel**, Brea; **Marc Booth**, La Habra; **Kaz Takata**, Placentia; **Karen Evensen**, Lake Forest; **Loi Ninh**, Ranch, all of Calif.

[73] Assignees: **Sony Corporation**, Tokyo, Japan; **Sony Trans Com Inc.**, Irvine, Calif.

[21] Appl. No.: **08/716,541**

[22] Filed: **Sep. 16, 1996**

[51] **Int. Cl.**[6] **H04N 7/16**

[52] **U.S. Cl.** **348/8**; 455/6.3

[58] **Field of Search** 348/7, 8, 12, 705, 348/722; 455/3.1, 6.3, 6.1

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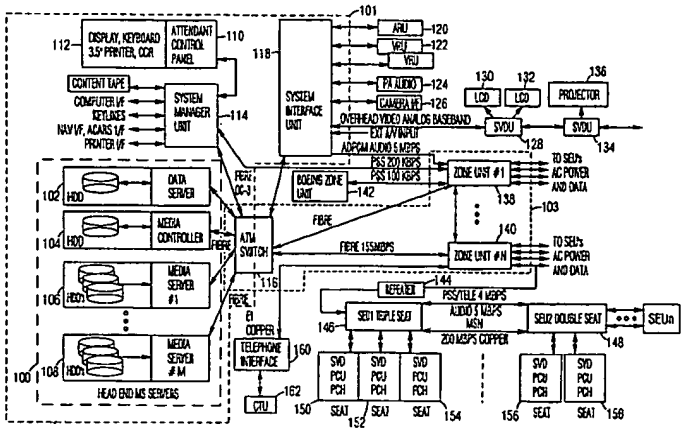
Primary Examiner—Chris Grant

Attorney, Agent, or Firm—Haverstock & Owens LLP

[57] **ABSTRACT**

An in-flight passenger entertainment system has a first digital network for communication among components of a headend system including a data server, media controller, one or more media servers, system interface unit, system manager unit and attendant control panel. The in-flight entertainment system is coupled to an aircraft's existing systems through the system interface unit and the system manager unit. The components of the headend system are all coupled to a network switch for routing data within the first network. The network switch is also coupled to one or more zone bridge units, each of which is coupled to multiple seat electronics units. The zone bridge units and the seat electronics units together form a second digital network. The first digital network is preferably an ATM network with fibre optic cables used to carry the data. The second digital network is preferably an IEEE 1394 serial bus network. The zone bridge units control all communications between the networks, converting all communications into the format required by the respective network. A first audio path for transmitting audio content from the headend system is routed to predetermined seat entertainment units through the network switch and the zone bridge units. A second audio path for transmitting audio from the system interface unit is routed to the seat entertainment units through the zone bridge units.

24 Claims, 16 Drawing Sheets



claim 8

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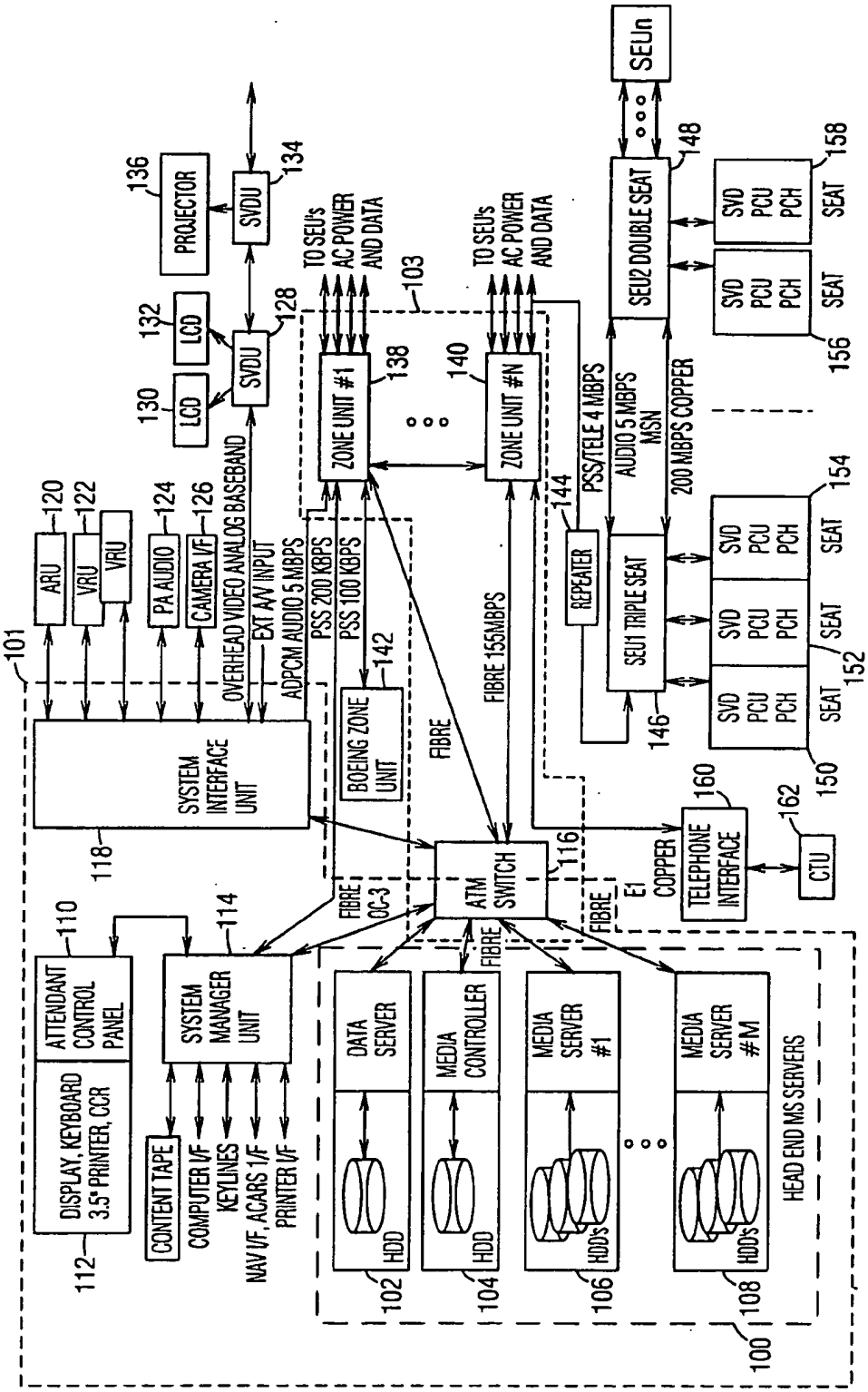

SEUn
148
SEU2 DOUBLE SEAT
SEU1 TRIPLE SEAT
REPEATER
144
PSS/TELE 4 MBPS
AUDIO 5 MBPS MSN
200 MBPS COPPER
TO SEU's AC POWER AND DATA
TO SEU's AC POWER AND DATA
103
ZONE UNIT #1
138
ZONE UNIT #N
140
SVDU
128
SVDU
134
PROJECTOR
136
LCD
132
LCD
130
OVERHEAD VIDEO ANALOG BASEBAND
EXT A/V INPUT
ADPCM AUDIO 5 MBPS
PSS 200 KBPS
PSS 100 KBPS
142
BOEING ZONE UNIT
FIBRE
FIBRE 155MBPS
ARU
120
VRU
122
VRU
PA AUDIO
124
CAMERA I/F
126
101
SYSTEM INTERFACE UNIT
118
ATM SWITCH
116
FIBRE OC-3
FIBRE
E1
COPPER
TELEPHONE INTERFACE
160
CTU
162
SVD PCU PCH
SEAT
152
154
156
158
150
146
ATTENDANT CONTROL PANEL
110
DISPLAY, KEYBOARD 3.5" PRINTER, CCR
112
SYSTEM MANAGER UNIT
114
CONTENT TAPE
COMPUTER I/F
KEYLINES
NAV I/F, ACARS I/F
PRINTER I/F
DATA SERVER
MEDIA CONTROLLER
MEDIA SERVER #1
MEDIA SERVER #M
HDD
HDDs
102
104
106
108
HEAD END MS SERVERS
100

Fig. 1

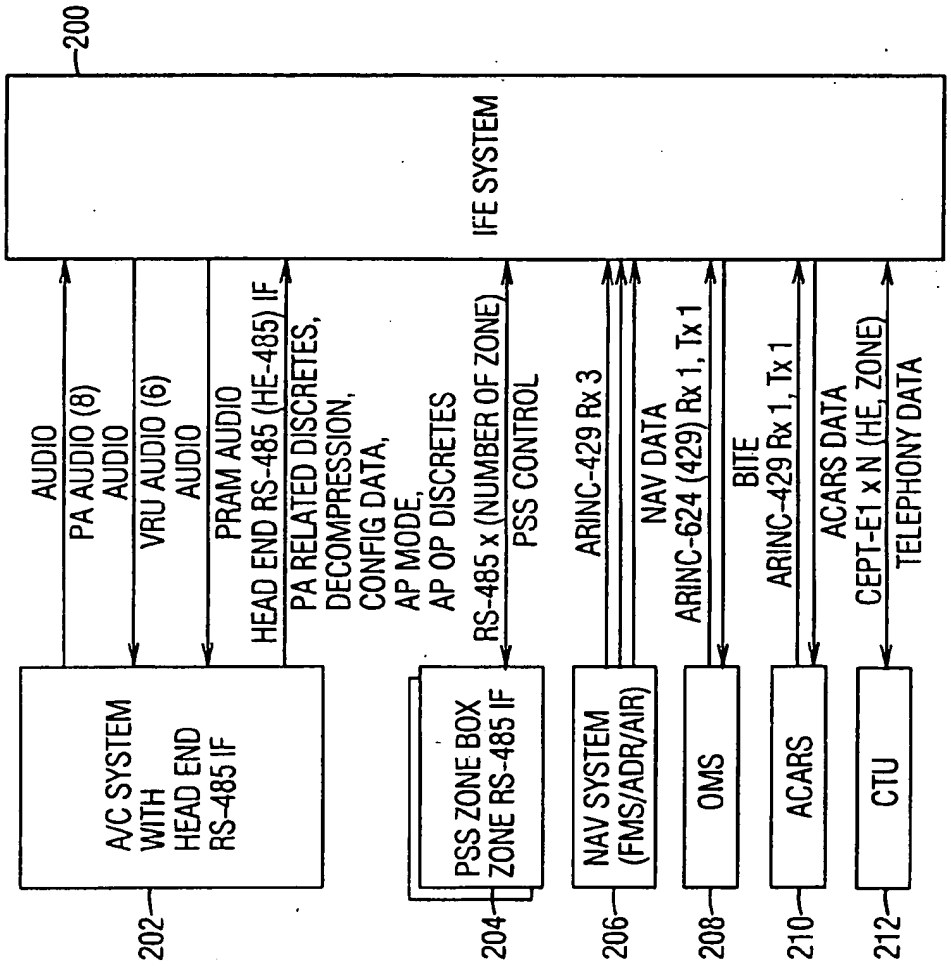

200
IFE SYSTEM
AUDIO
PA AUDIO (8)
AUDIO
VRU AUDIO (6)
AUDIO
PRAM AUDIO
HEAD END RS-485 (HE-485) IF
PA RELATED DISCRETES,
DECOMPRESSION,
CONFIG DATA,
AP MODE,
AP OP DISCRETES
RS-485 x (NUMBER OF ZONE)
PSS CONTROL
ARINC-429 Rx 3
NAV DATA
ARINC-624 (429) Rx 1, Tx 1
BITE
ARINC-429 Rx 1, Tx 1
ACARS DATA
CEPT-E1 x N (HE, ZONE)
TELEPHONY DATA
A/C SYSTEM
WITH
HEAD END
RS-485 IF
PSS ZONE BOX
ZONE RS-485 IF
NAV SYSTEM
(FMS/ADR/AIR)
OMS
ACARS
CTU
202
204
206
208
210
212

Fig. 2

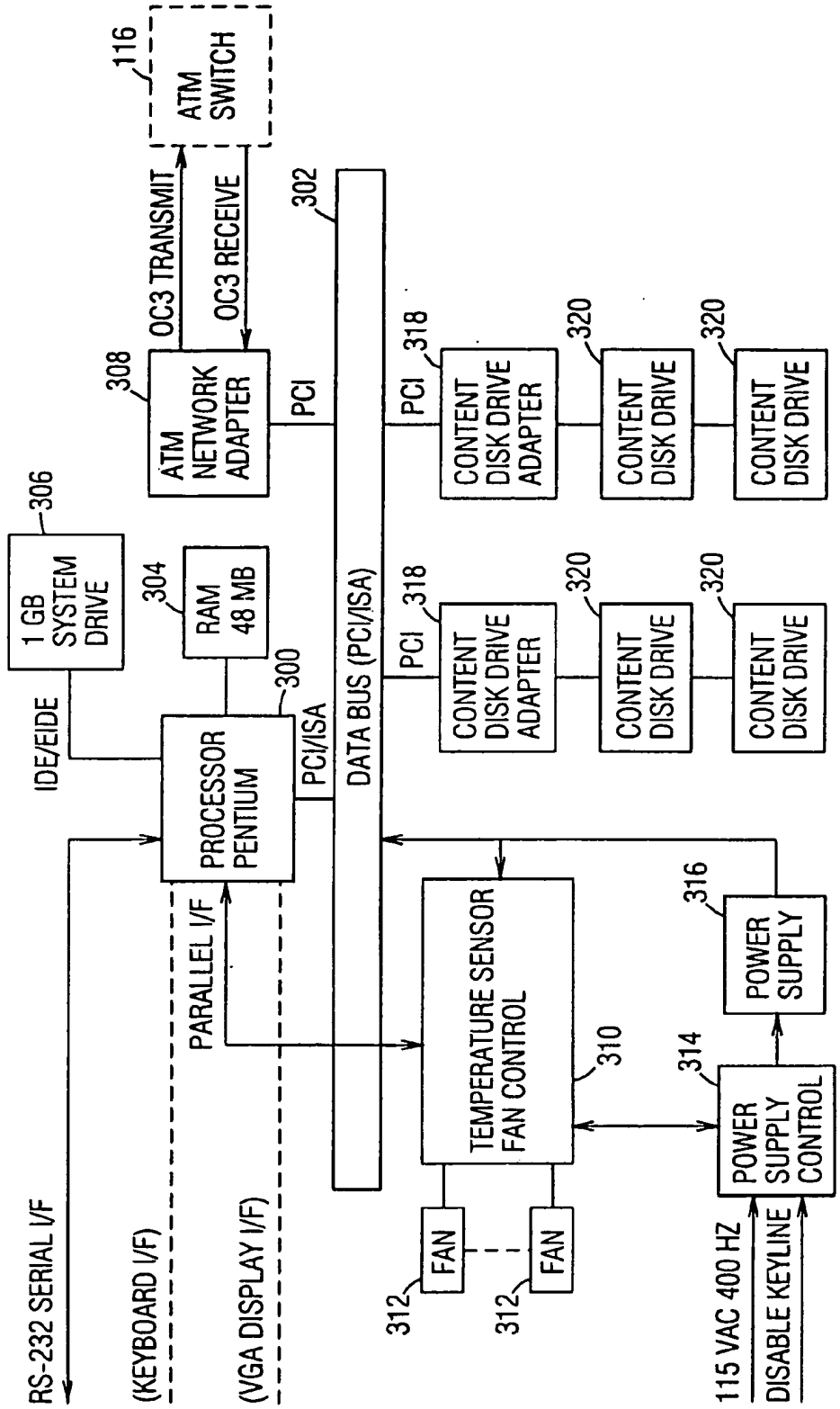

116
ATM SWITCH
OC3 TRANSMIT
OC3 RECEIVE
308
ATM NETWORK ADAPTER
PCI
302
DATA BUS (PCI/ISA)
PCI
318
CONTENT DISK DRIVE ADAPTER
320
CONTENT DISK DRIVE
320
CONTENT DISK DRIVE
306
1 GB SYSTEM DRIVE
304
RAM 48 MB
300
PROCESSOR PENTIUM
PCI/ISA
IDE/EIDE
PCI
318
CONTENT DISK DRIVE ADAPTER
320
CONTENT DISK DRIVE
320
CONTENT DISK DRIVE
PARALLEL I/F
TEMPERATURE SENSOR FAN CONTROL
310
316
POWER SUPPLY
314
POWER SUPPLY CONTROL
RS-232 SERIAL I/F
(KEYBOARD I/F)
(VGA DISPLAY I/F)
312
FAN
312
FAN
115 VAC 400 HZ
DISABLE KEYLINE

Fig. 3

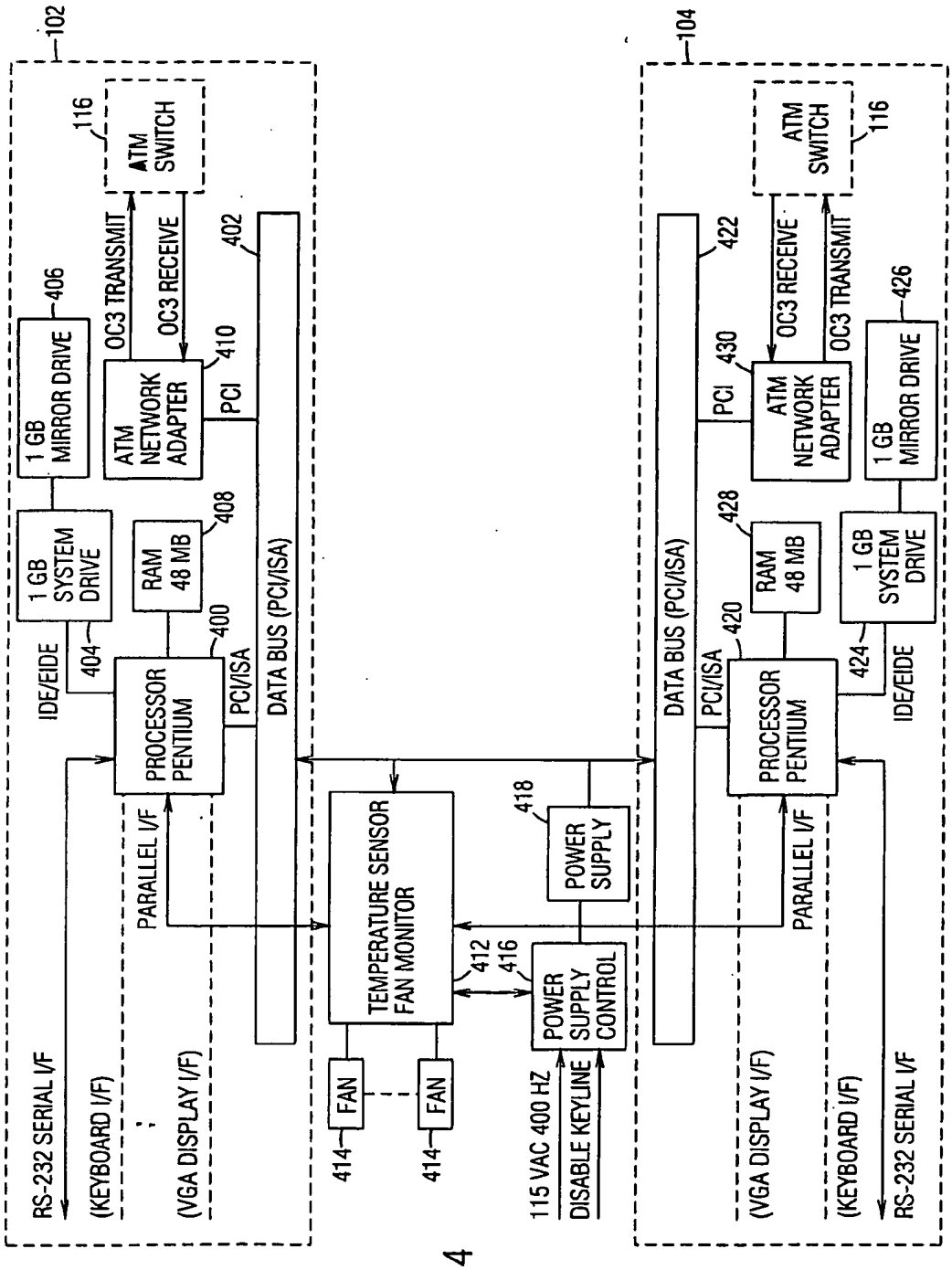

102
104
116
ATM SWITCH
OC3 TRANSMIT
OC3 RECEIVE
406
1 GB MIRROR DRIVE
ATM NETWORK ADAPTER
410
PCI
402
DATA BUS (PCI/ISA)
1 GB SYSTEM DRIVE
RAM 48 MB
408
IDE/EIDE
404
PROCESSOR PENTIUM
400
PCI/ISA
PARALLEL I/F
TEMPERATURE SENSOR FAN MONITOR
412
FAN
414
POWER SUPPLY
418
POWER SUPPLY CONTROL
416
115 VAC 400 HZ
DISABLE KEYLINE
RS-232 SERIAL I/F
(KEYBOARD I/F)
(VGA DISPLAY I/F)
422
430
426
428
420
424

Fig. 4

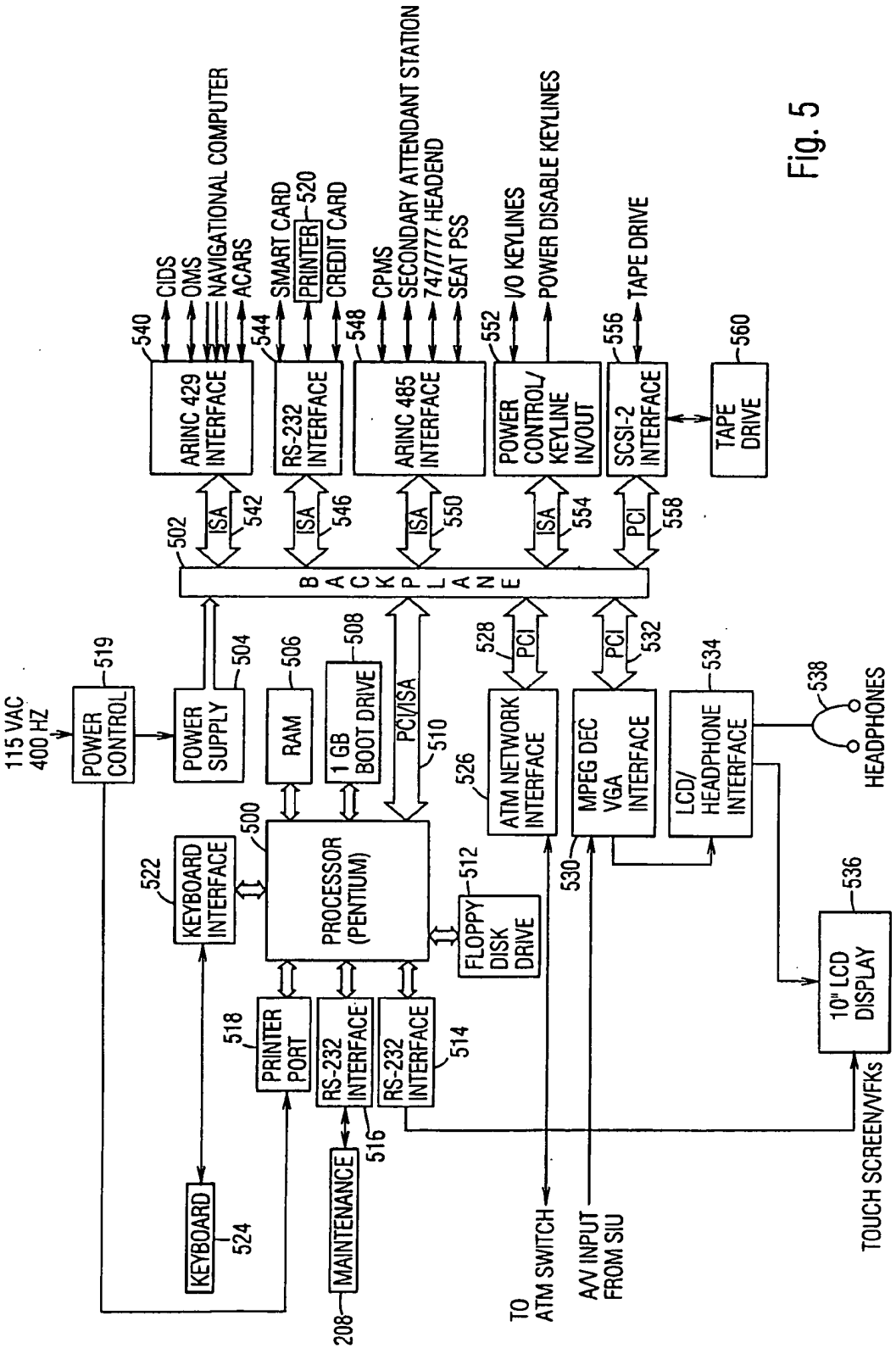

115 VAC 400 HZ
POWER CONTROL
519
POWER SUPPLY
504
RAM
506
1 GB BOOT DRIVE
508
PCI/ISA
510
PROCESSOR (PENTIUM)
500
KEYBOARD INTERFACE
522
KEYBOARD
524
PRINTER PORT
518
RS-232 INTERFACE
516
MAINTENANCE
208
RS-232 INTERFACE
514
FLOPPY DISK DRIVE
512
ATM NETWORK INTERFACE
526
TO ATM SWITCH
MPEG DEC VGA INTERFACE
530
A/V INPUT FROM SIU
LCD/ HEADPHONE INTERFACE
534
HEADPHONES
538
10" LCD DISPLAY
536
TOUCH SCREEN/VFKs
BACKPLANE
502
ISA
542
ISA
546
ISA
550
ISA
554
PCI
558
PCI
528
PCI
532
ARINC 429 INTERFACE
540
CIDS
OMS
NAVIGATIONAL COMPUTER
ACARS
RS-232 INTERFACE
544
SMART CARD
PRINTER
520
CREDIT CARD
ARINC 485 INTERFACE
548
CPMS
SECONDARY ATTENDANT STATION
747/777 HEADEND
SEAT PSS
POWER CONTROL/ KEYLINE IN/OUT
552
I/O KEYLINES
POWER DISABLE KEYLINES
SCSI-2 INTERFACE
556
TAPE DRIVE
TAPE DRIVE
560

Fig. 5

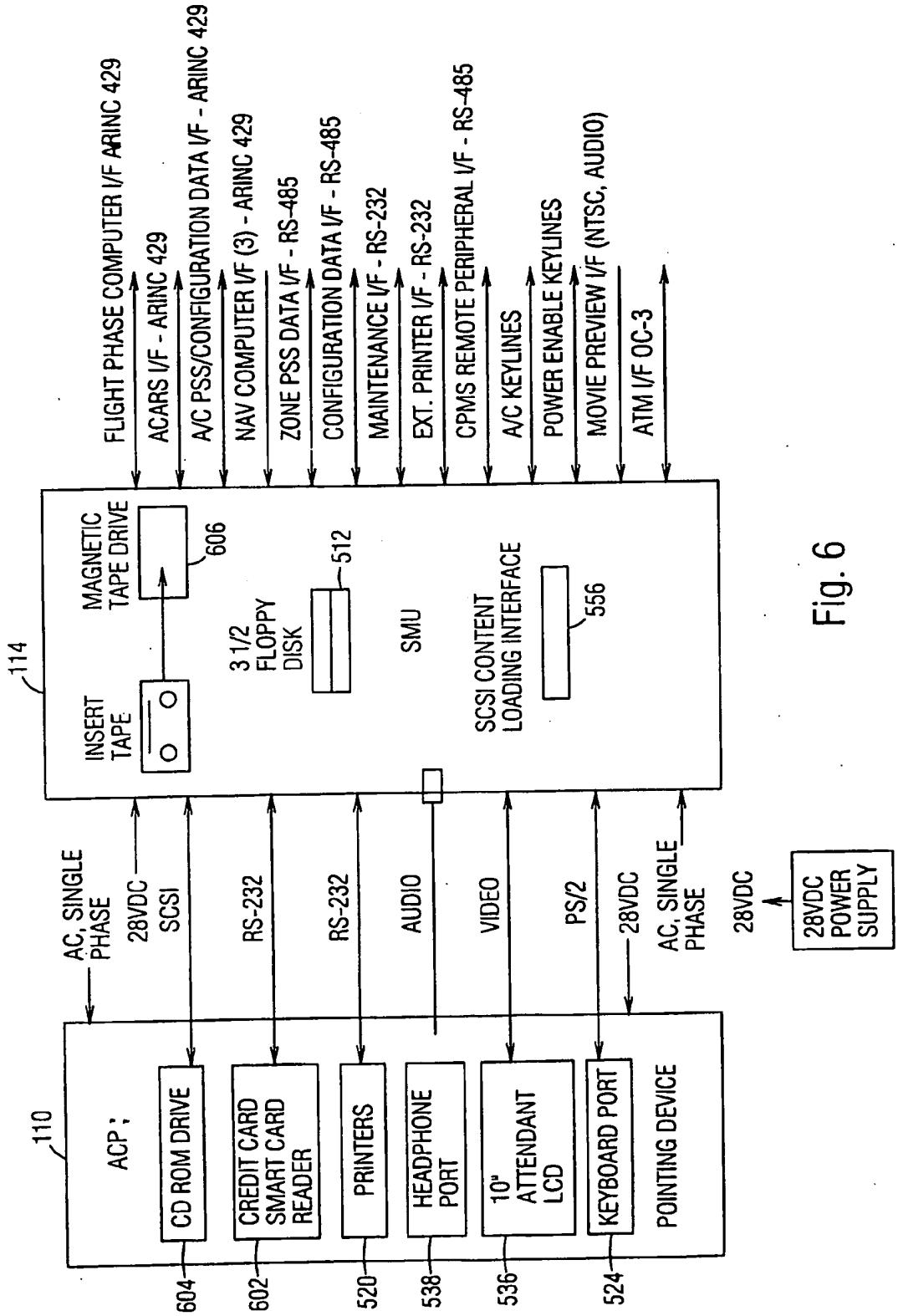

FLIGHT PHASE COMPUTER I/F ARINC 429
ACARS I/F - ARINC 429
A/C PSS/CONFIGURATION DATA I/F - ARINC 429
NAV COMPUTER I/F (3) - ARINC 429
ZONE PSS DATA I/F - RS-485
CONFIGURATION DATA I/F - RS-485
MAINTENANCE I/F - RS-232
EXT. PRINTER I/F - RS-232
CPMS REMOTE PERIPHERAL I/F - RS-485
A/C KEYLINES
POWER ENABLE KEYLINES
MOVIE PREVIEW I/F (NTSC, AUDIO)
ATM I/F OC-3
114
MAGNETIC TAPE DRIVE
606
INSERT TAPE
3 1/2 FLOPPY DISK
512
SMU
SCSI CONTENT LOADING INTERFACE
556
AC, SINGLE PHASE
28VDC
SCSI
RS-232
RS-232
AUDIO
VIDEO
PS/2
28VDC
AC, SINGLE PHASE
28VDC
28VDC POWER SUPPLY
110
ACP;
CD ROM DRIVE
CREDIT CARD SMART CARD READER
PRINTERS
HEADPHONE PORT
10" ATTENDANT LCD
KEYBOARD PORT
POINTING DEVICE
604
602
520
538
536
524

Fig. 6

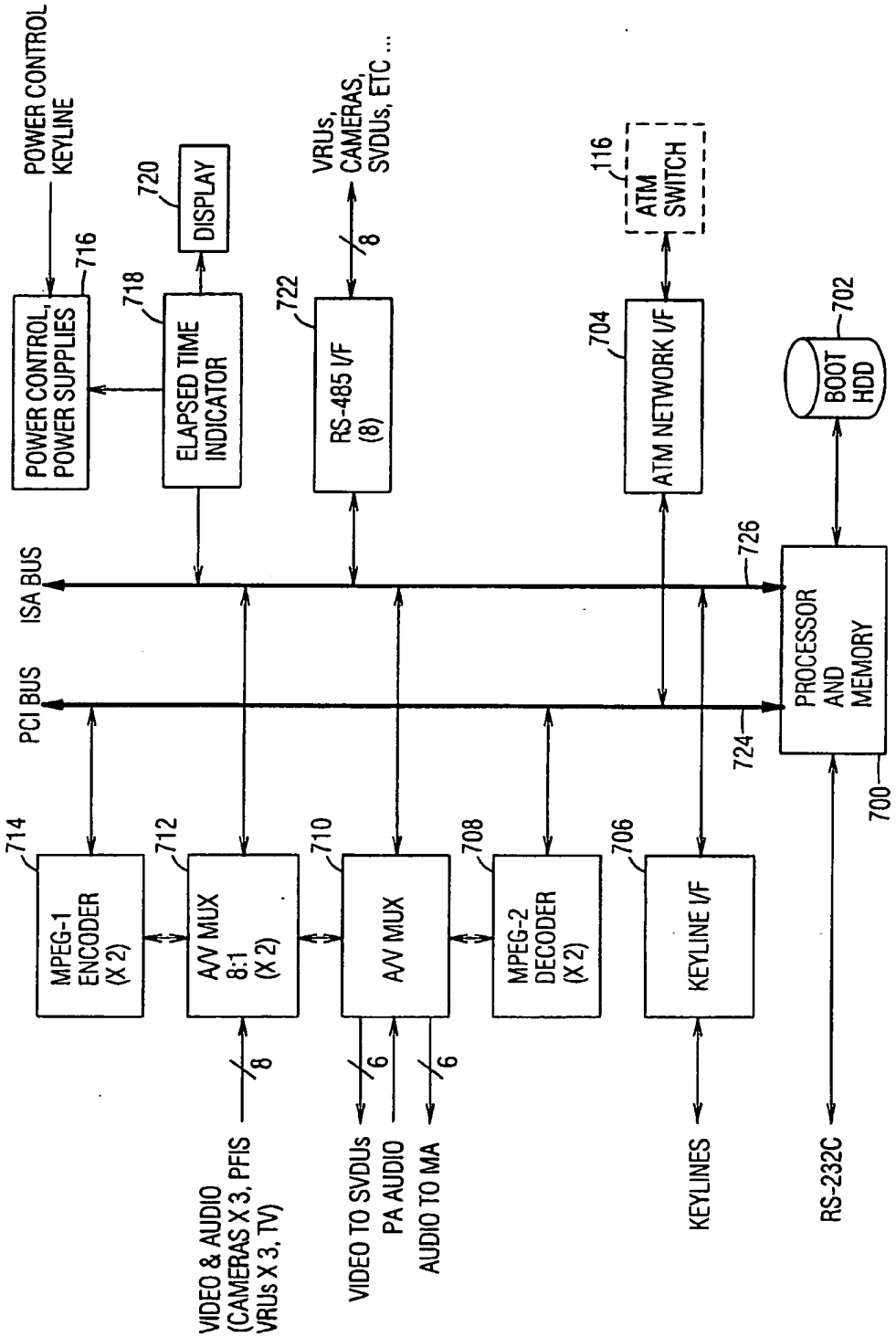

POWER CONTROL
KEYLINE
716
POWER CONTROL,
POWER SUPPLIES
718
ELAPSED TIME
INDICATOR
720
DISPLAY
VRUs,
CAMERAS,
SVDUs, ETC ...
8
722
RS-485 I/F
(8)
116
ATM
SWITCH
704
ATM NETWORK I/F
702
BOOT
HDD
ISA BUS
726
PCI BUS
PROCESSOR
AND
MEMORY
724
700
714
MPEG-1
ENCODER
(X 2)
712
A/V MUX
8:1
(X 2)
710
A/V MUX
708
MPEG-2
DECODER
(X 2)
706
KEYLINE I/F
8
6
6
VIDEO & AUDIO
(CAMERAS X 3, PFIS
VRUs X 3, TV)
VIDEO TO SVDUs
PA AUDIO
AUDIO TO MA
KEYLINES
RS-232C

Fig. 7

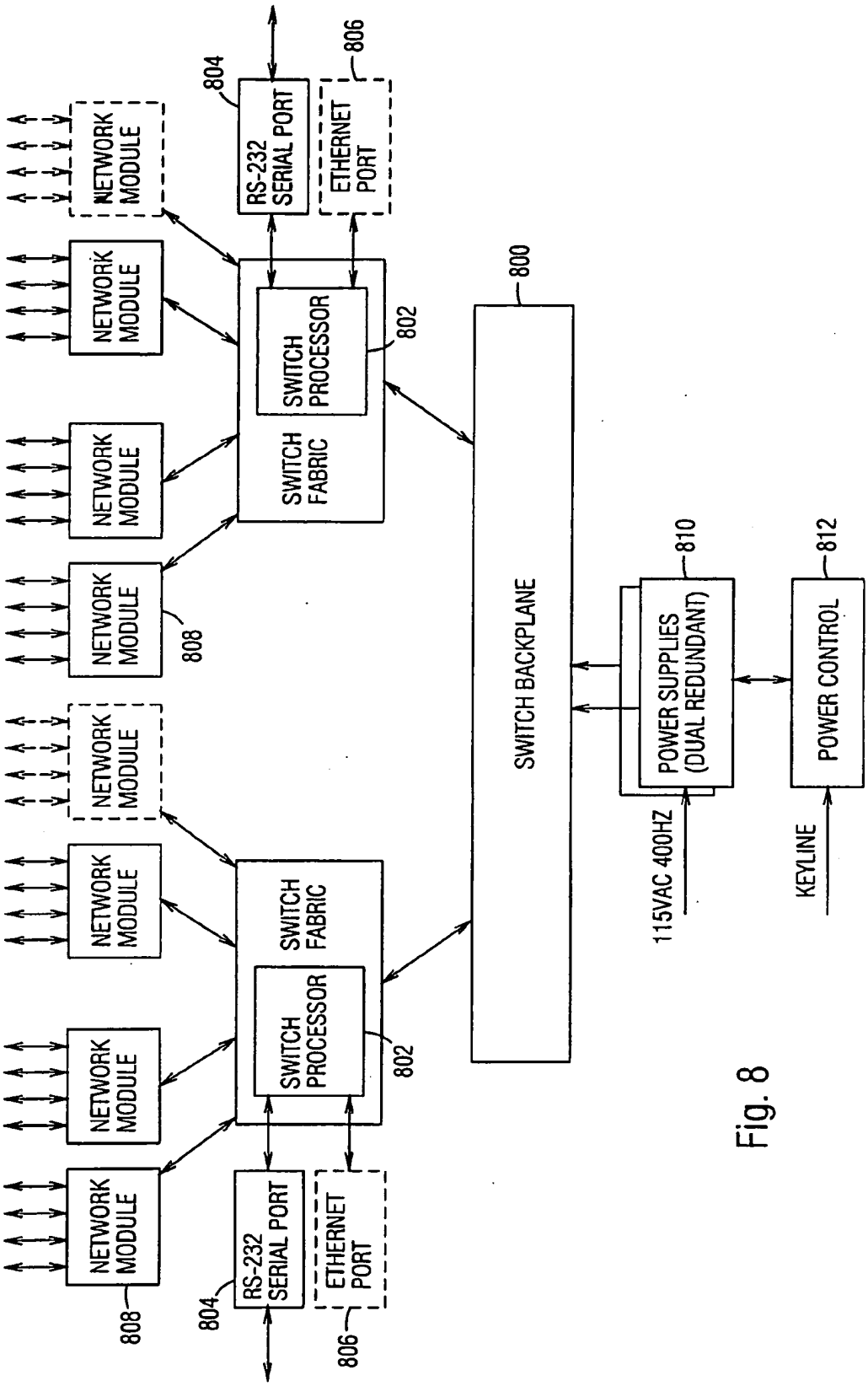

NETWORK MODULE
NETWORK MODULE
NETWORK MODULE
NETWORK MODULE
808
NETWORK MODULE
NETWORK MODULE
NETWORK MODULE
NETWORK MODULE
808
804
RS-232 SERIAL PORT
ETHERNET PORT
806
SWITCH PROCESSOR
SWITCH FABRIC
802
804
RS-232 SERIAL PORT
ETHERNET PORT
806
SWITCH PROCESSOR
SWITCH FABRIC
802
800
SWITCH BACKPLANE
POWER SUPPLIES (DUAL REDUNDANT)
810
115VAC 400HZ
POWER CONTROL
812
KEYLINE

Fig. 8

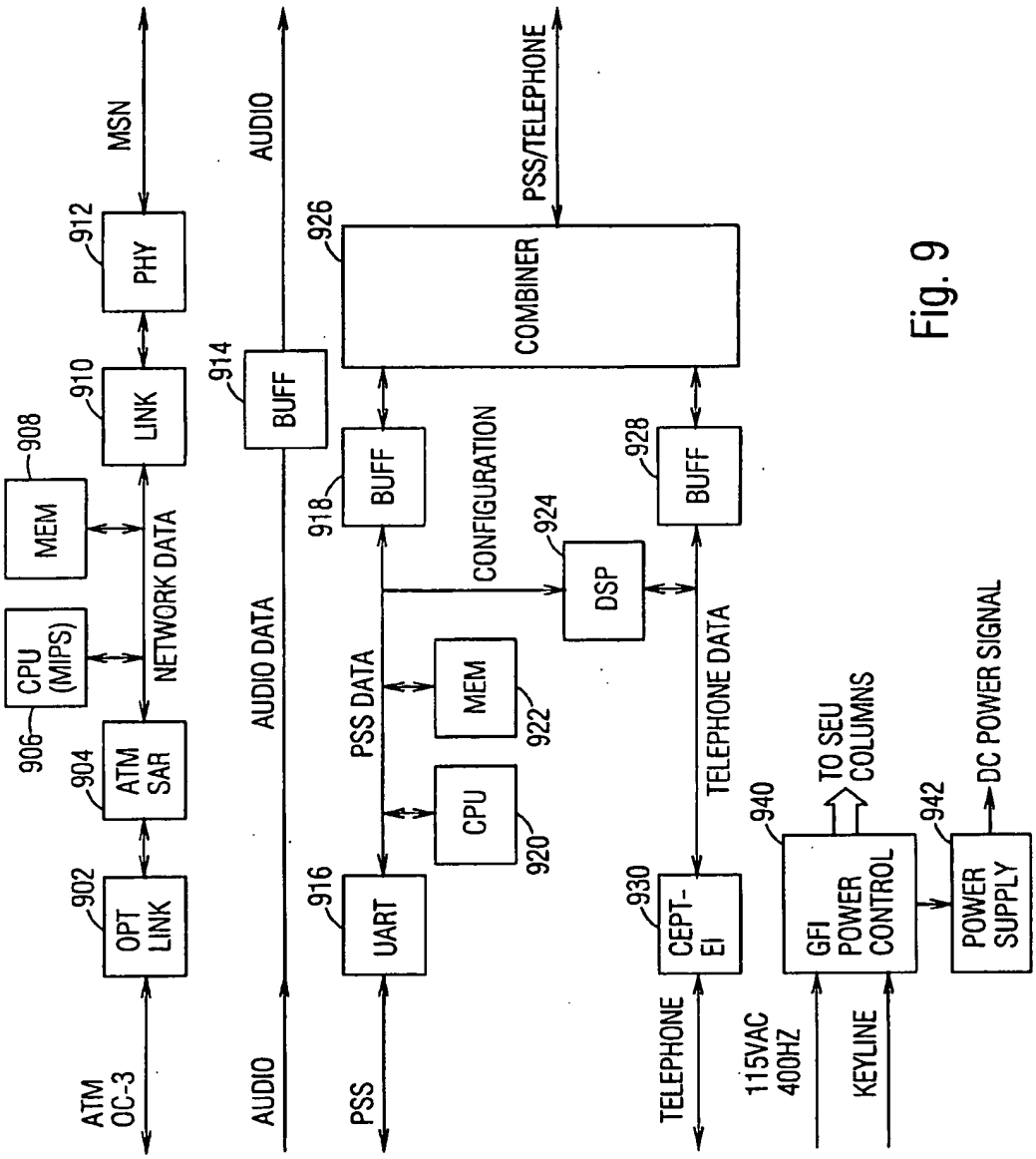

MSN
912
PHY
910
LINK
908
MEM
CPU (MIPS)
906
NETWORK DATA
904
ATM SAR
902
OPT LINK
ATM OC-3
AUDIO
914
BUFF
AUDIO DATA
AUDIO
926
COMBINER
PSS/TELEPHONE
918
BUFF
CONFIGURATION
924
DSP
928
BUFF
PSS DATA
MEM
922
CPU
920
916
UART
PSS
TELEPHONE DATA
930
CEPT-EI
TELEPHONE
940
GFI POWER CONTROL
TO SEU COLUMNS
115VAC 400HZ
KEYLINE
942
POWER SUPPLY
DC POWER SIGNAL

Fig. 9

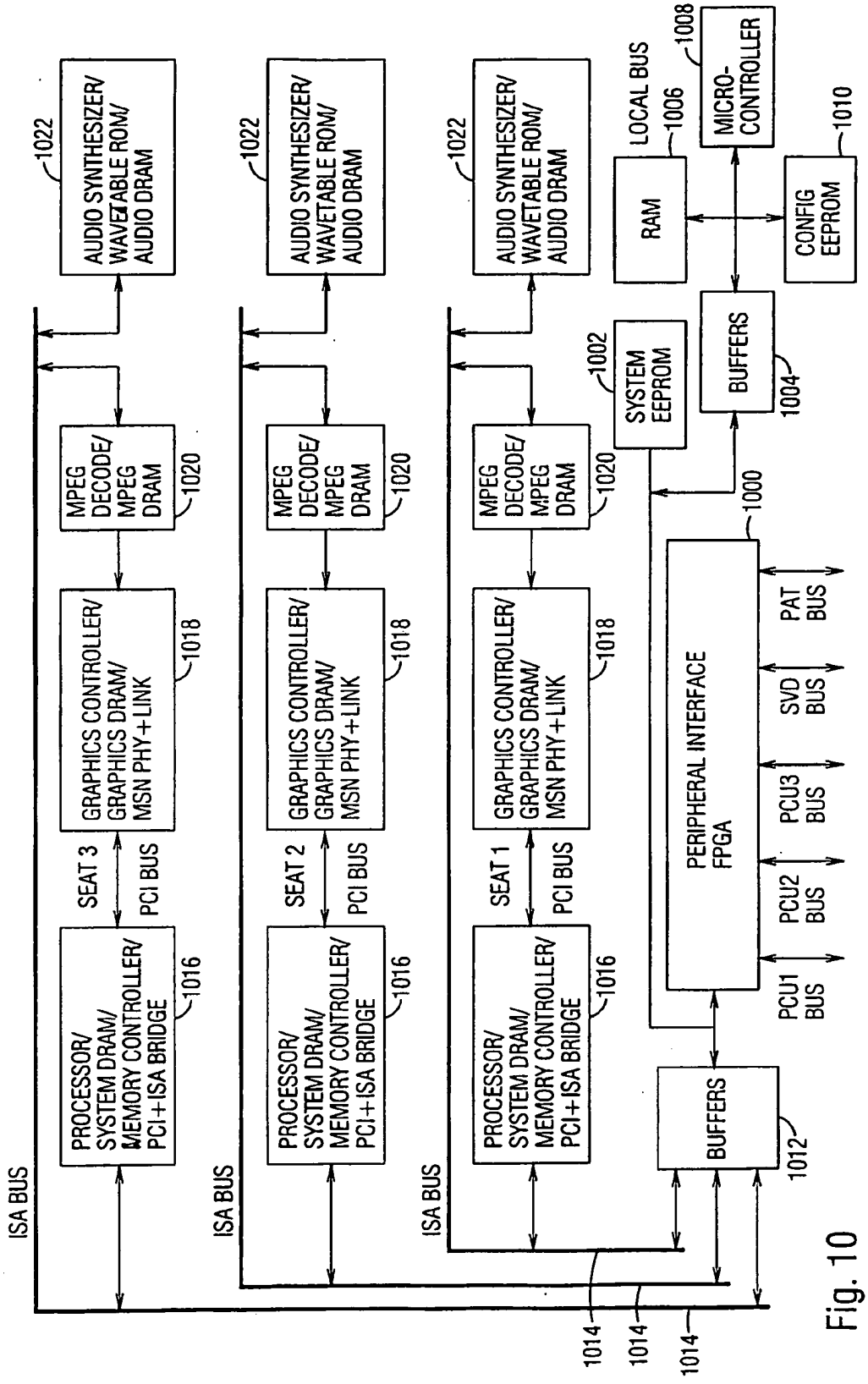

ISA BUS
PROCESSOR/ SYSTEM DRAM/ MEMORY CONTROLLER/ PCI+ISA BRIDGE
1016
SEAT 3
PCI BUS
GRAPHICS CONTROLLER/ GRAPHICS DRAM/ MSN PHY+LINK
1018
MPEG DECODE/ MPEG DRAM
1020
AUDIO SYNTHESIZER/ WAVETABLE ROM/ AUDIO DRAM
1022
SEAT 2
PCI BUS
SEAT 1
PCI BUS
1014
BUFFERS
1012
PERIPHERAL INTERFACE FPGA
1000
PCU1 BUS
PCU2 BUS
PCU3 BUS
SVD BUS
PAT BUS
SYSTEM EEPROM
1002
BUFFERS
1004
RAM
LOCAL BUS
1006
MICRO-CONTROLLER
1008
CONFIG EEPROM
1010

Fig. 10

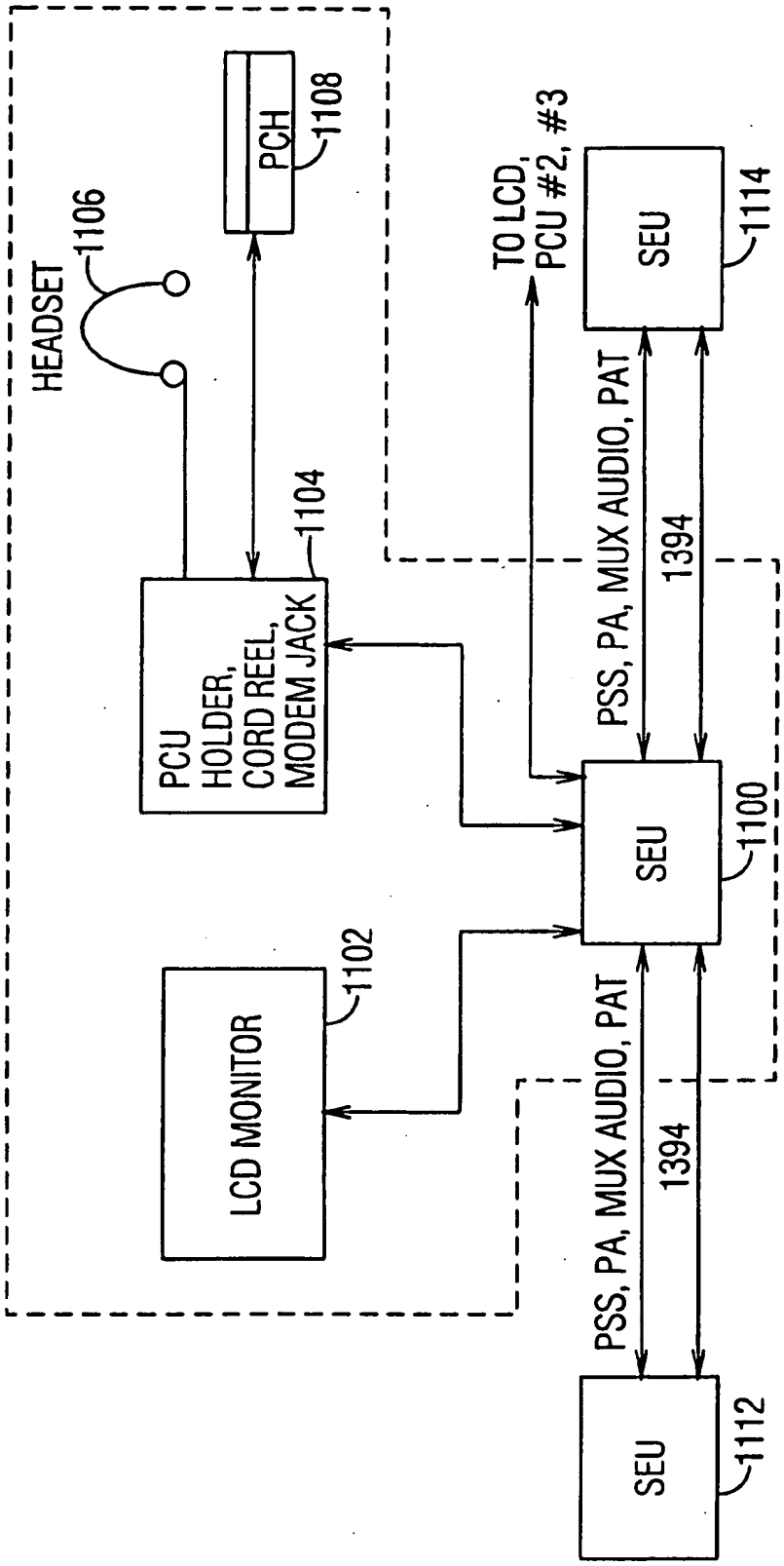

HEADSET
1106
PCH
1108
1104
PCU
HOLDER,
CORD REEL,
MODEM JACK
LCD MONITOR
1102
TO LCD,
PCU #2, #3
SEU
1114
PSS, PA, MUX AUDIO, PAT
1394
SEU
1100
PSS, PA, MUX AUDIO, PAT
1394
SEU
1112

Fig. 11

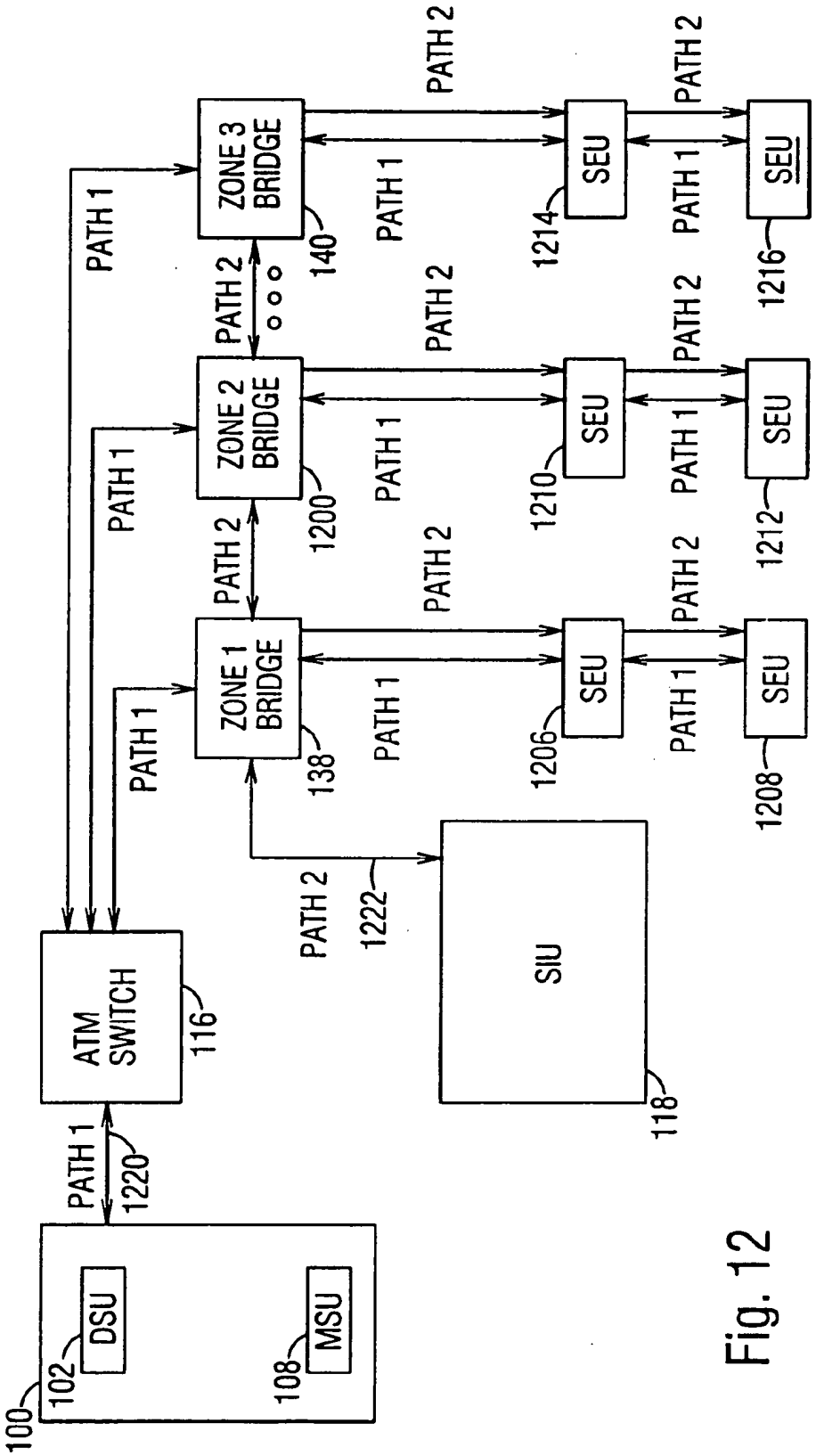

ZONE 3 BRIDGE
ZONE 2 BRIDGE
ZONE 1 BRIDGE
SEU
SEU
SEU
SEU
SEU
SEU
ATM SWITCH
SIU
DSU
MSU
PATH 1
PATH 2
140
1214
1216
1200
1210
1212
138
1206
1208
1222
116
118
102
108
100
1220

Fig. 12

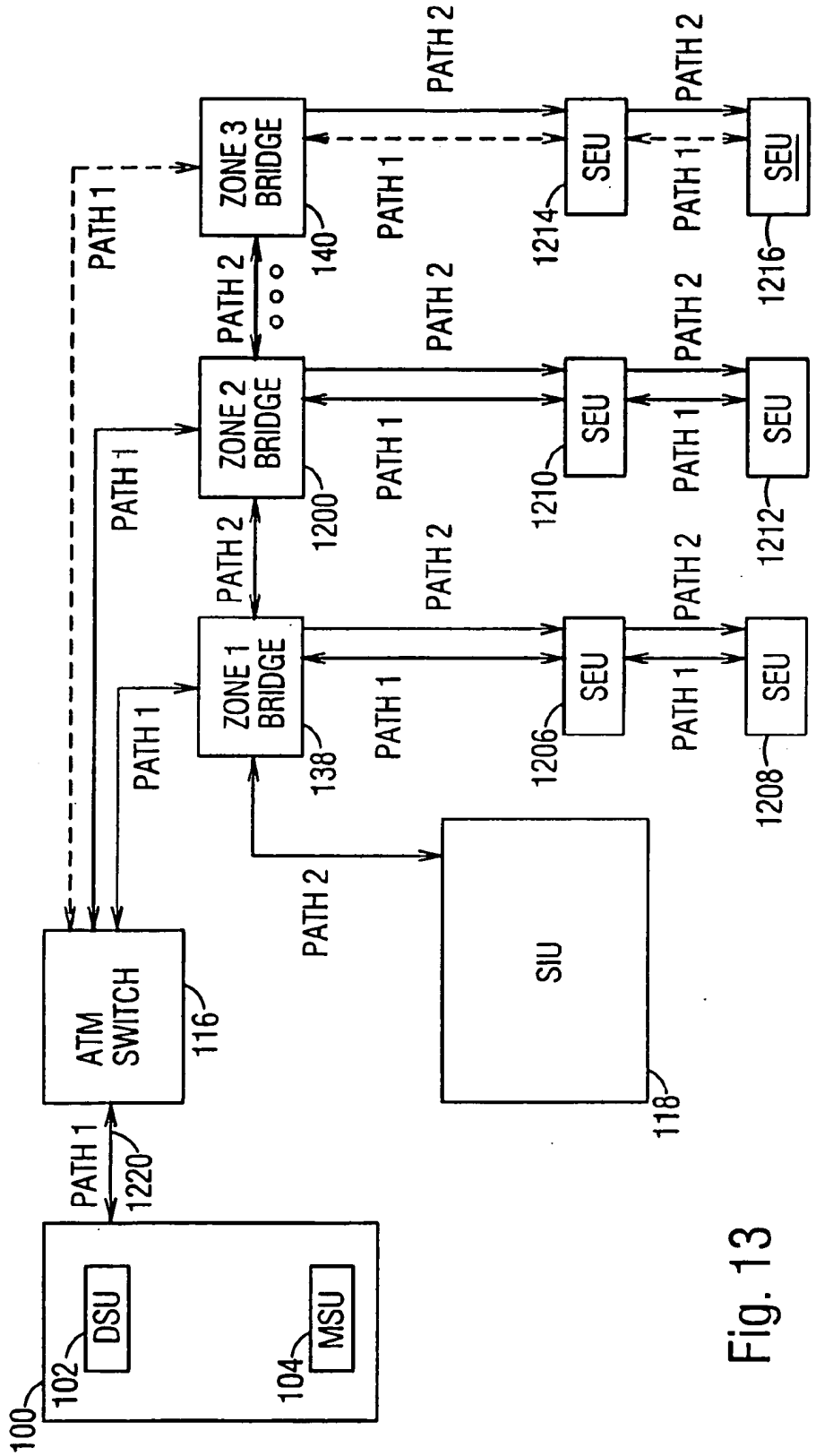
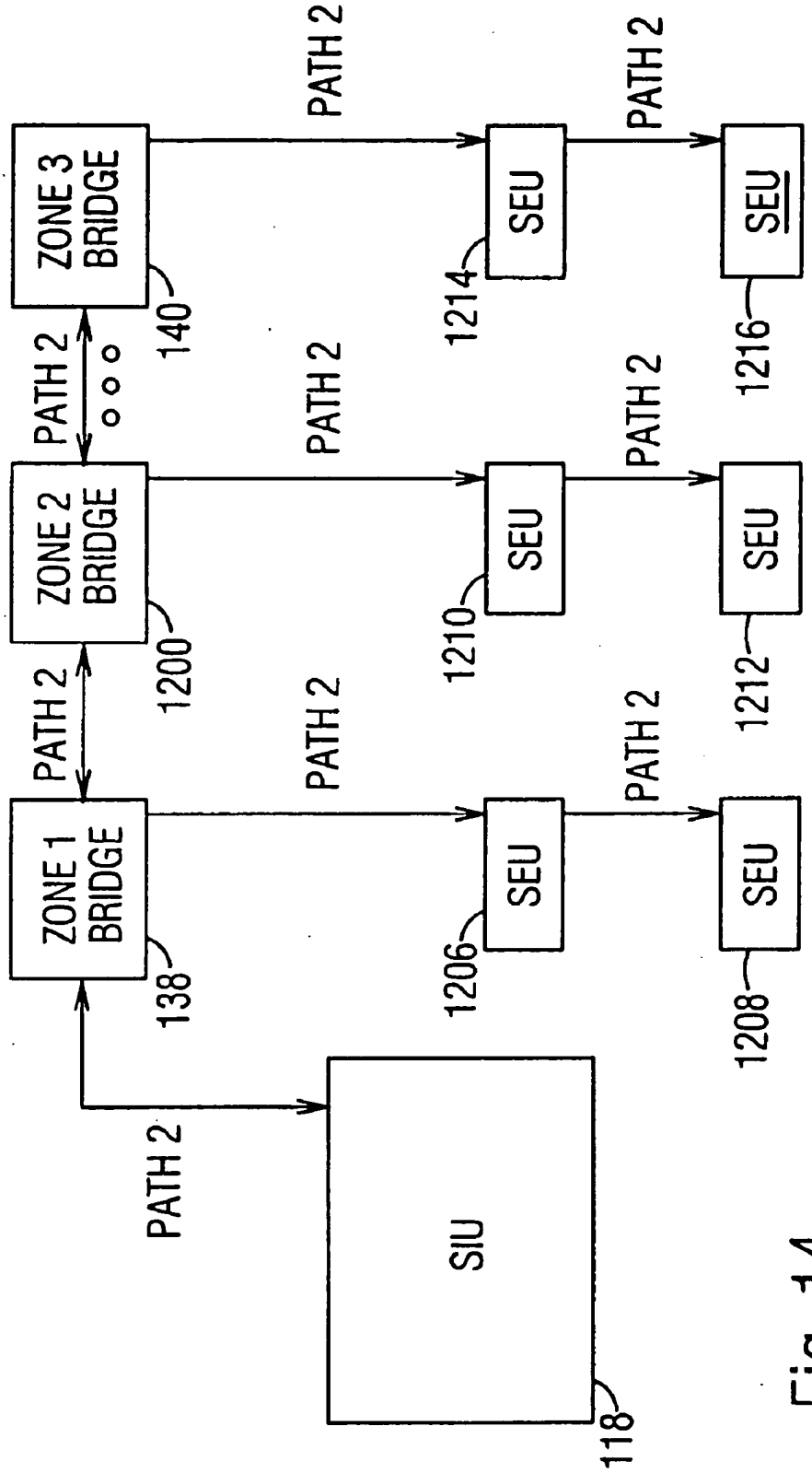

PATH 1
PATH 2
ZONE 3 BRIDGE
ZONE 2 BRIDGE
ZONE 1 BRIDGE
140
1200
138
SEU
1214
1216
1210
1212
1206
1208
SIU
118
ATM SWITCH
116
1220
DSU
102
MSU
104
100

Fig. 13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140
ZONE 2 BRIDGE
1200
ZONE 1 BRIDGE
138
PATH 2
SEU
1214
1216
1210
1212
1206
1208
SIU
118

Fig. 14

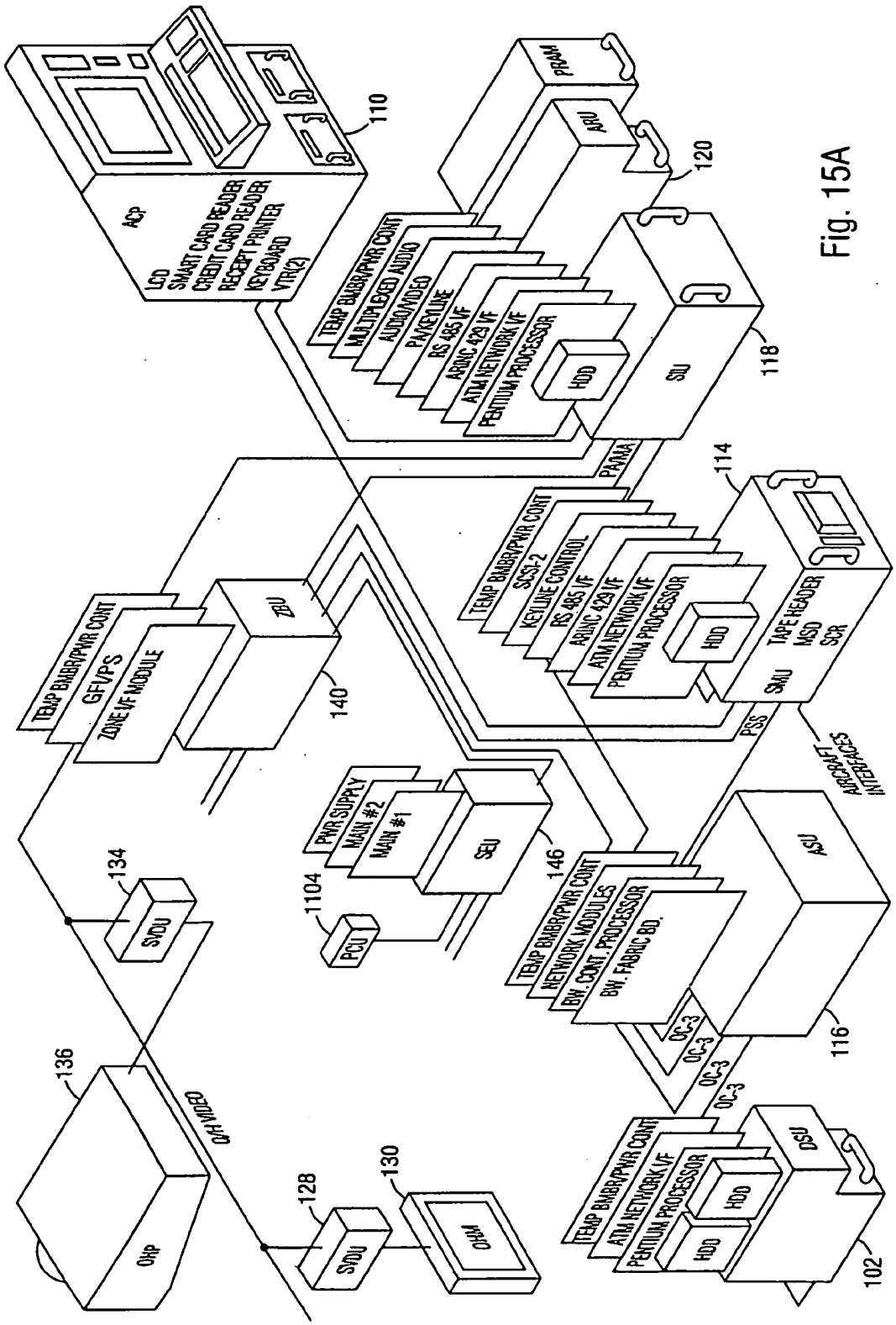
ACP
LCD
SMART CARD READER
CREDIT CARD READER
RECEIPT PRINTER
KEYBOARD
YTRK(2)
110
PRAM
ARU
120
TEMP BMBR/PWR CONT
MULTIPLEXED AUDIO
AUDIO/VIDEO
PA/KEYLINE
RS 485 I/F
ARINC 429 I/F
ATM NETWORK I/F
PENTIUM PROCESSOR
HDD
SIU
118
PARMA
114
TEMP BMBR/PWR CONT
SVGS-2
KEYLINE CONTROL
RS 485 I/F
ARINC 429 I/F
ATM NETWORK I/F
PENTIUM PROCESSOR
HDD
TAPE HEADER
MSD
SCR
SMU
PSS
AIRCRAFT INTERFACES
TEMP BMBR/PWR CONT
GFI/PS
ZONE I/F MODULE
ZBU
140
PWR SUPPLY
MAIN #2
MAIN #1
SEU
146
1104
PCU
134
SYDU
TEMP BMBR/PWR CONT
NETWORK MODULES
BW. CONT. PROCESSOR
BW. FABRIC BD.
ASU
116
OC-3
OC-3
OC-3
136
OHP
OHP VIDEO
128
SYDU
130
OHM
TEMP BMBR/PWR CONT
ATM NETWORK I/F
PENTIUM PROCESSOR
HDD
HDD
DSU
102

Fig. 15A

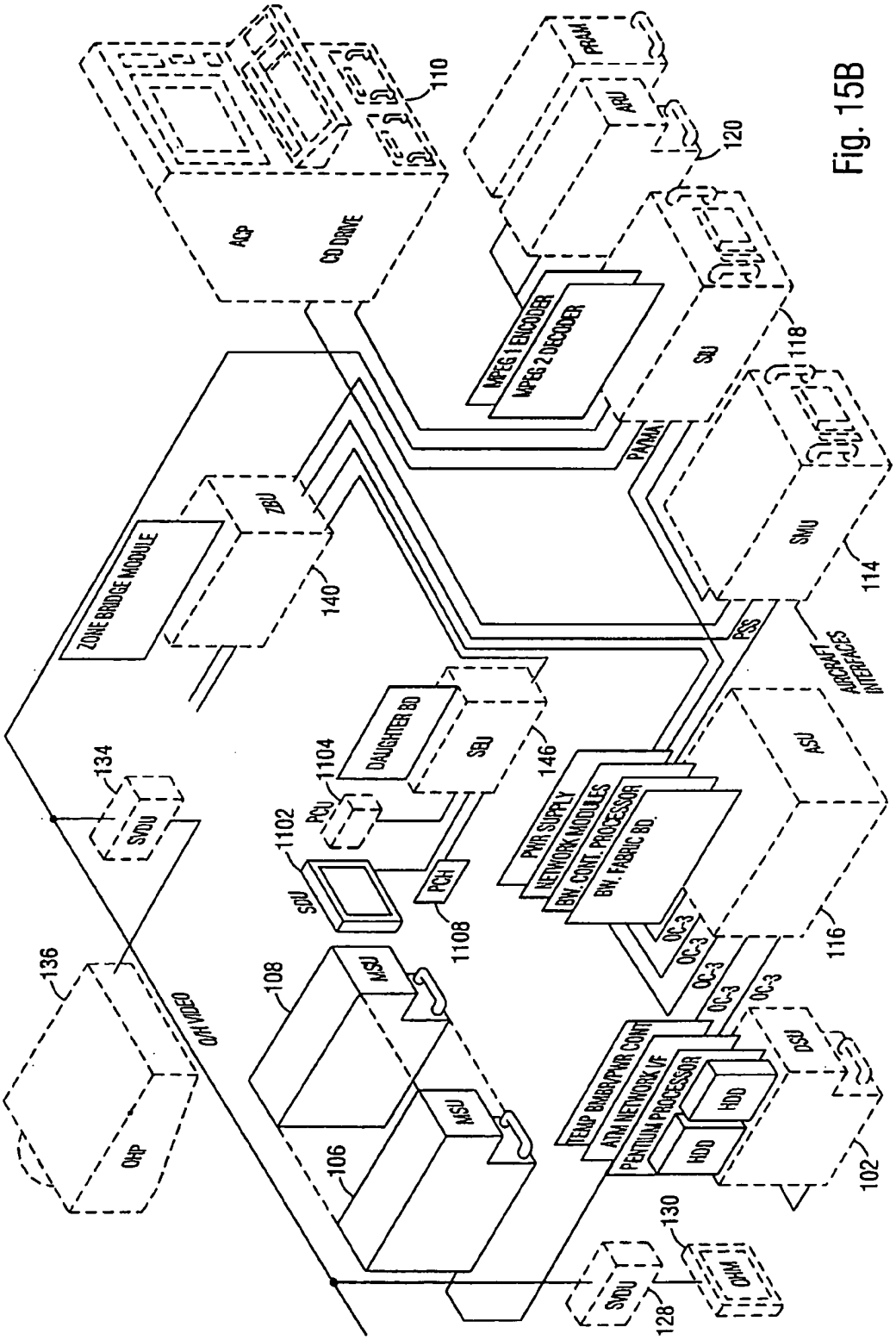
110
ACP
CD DRIVE
PRAM
ADU
120
MPEG 1 ENCODER
MPEG 2 DECODER
SIU
118
PANA
SMU
114
ZBU
ZONE BRIDGE MODULE
140
PSS
AIRCRAFT INTERFACES
DAUGHTER BD
SBU
1104
146
134
SVDU
PCU
1102
SDU
PCH
1108
PWR SUPPLY
NETWORK MODULES
BW. CONT. PROCESSOR
BW. FABRIC BD.
ADU
OC-3
116
136
OHP
OH VIDEO
108
MSU
106
TEMP BMBR/PWR CONT
ATM NETWORK I/F
PENTIUM PROCESSOR
HDD
HDD
DSU
102
130
SVDU
128
OHM

Fig. 15B

COMBINED DIGITAL AUDIO/VIDEO ON DEMAND AND BROADCAST DISTRIBUTION SYSTEM

FIELD OF THE INVENTION

The present invention relates to the field of audio and video on demand entertainment systems. More particularly, the present invention relates to the field of distributed network video on demand entertainment and broadcast distribution systems for use onboard an aircraft during flight.

BACKGROUND OF THE INVENTION

In-flight entertainment on an airplane has traditionally consisted of the ability to watch a single video on an overhead screen and listen to one of multiple audio channels through a headset. The overhead screens are distributed throughout the airplane's cabin and are sometimes difficult to view from some seats within the cabin. The video is chosen by the airline and played simultaneously for viewing by all passengers. In most instances, a passenger desiring to hear the audio accompanying a featured film must rent or purchase a headset to be plugged into their seat console. A passenger who leaves their seat to stretch, go to the restroom or make a telephone call will end up missing a portion of the movie. Typically, the same feature film is played for a predetermined period of time on an airline, such as a calendar month, with different feature films played during travel in different directions within specific regions. For example, a first film will typically be played during travel within the United States in a western direction and a second film will be played during the same time period during travel within the United States in an eastern direction. Accordingly, for travellers travelling frequently during the same time period, it is highly likely that they will be on multiple flights featuring the same feature film. The airline is therefore losing potential revenue because it is likely that the passenger will not purchase a headset to view a movie that they have already watched.

Video on demand in-flight entertainment systems are being developed by multiple companies to provide numerous entertainment options to each passenger, thereby reducing the likelihood that a passenger has already viewed every option on the system. Video on demand entertainment systems typically include a control system and distributed individual video and audio systems of some form at each seat. Thus, each passenger with access to an individual video on demand entertainment unit has the ability to choose from among multiple movies, audio channels, video games, including gambling and other entertainment options. Previous video on demand systems have offered featured films at selected start increments during the airplane's flight, such as every ten minutes. With such systems, a passenger who leaves their seat to stretch, go to the restroom or make a telephone call, will still miss a portion of the movie. Each passenger however, is able to choose from among multiple feature films, reducing the likelihood that they have viewed all of the available movie options.

Some or all of these video on demand entertainment options are provided at an additional cost to the passenger. This cost can be collected through a credit card reader, integrated into the video on demand system, at each passenger's seat. The passenger can swipe their credit card through the credit card reader and can then choose the video on demand features which they desire to view or play. The cost of the chosen feature will then be automatically charged to the passenger's credit card. In this manner, gambling

services can also be provided to passengers through the video on demand entertainment system, allowing a passenger to wager up to a specified limit, secured by authorization to charge their credit card. When the passenger is finished using the gambling services, the amount that the passenger has won or lost is credited or charged to their credit card.

One such video on demand in-flight entertainment system has been developed by Interactive Flight Technologies of Las Vegas, Nev. This system is advertised to allow a passenger to choose from among thirty feature films, gambling, on-board shopping, video games and an Airshow feature. Airshow is a moving map display feature, provided by Airshow of Tustin, Calif., which allows the passenger to view the route of the current flight and the airplane's current position along that route. This video on demand system is controlled by cluster computers which serve groups of seats. Each seat is equipped with a 486 compatible computer with an integral hard drive and RAM, through which the user accesses the video on demand system.

Another video on demand in-flight entertainment system has been developed by B/E Aerospace of Irvine, Calif. This system is advertised to provide a passenger with over 500 channels for regular video programming such as movies, as well as live broadcast television and a variety of interactive features such as video games. This system also provides duty-free and catalog shopping, information menus, and both ground-base and satellite in-cabin telephone distribution through an individual video on demand module at the passenger's seat. The control electronics for this system are installed in a former galley unit on the aircraft which has been retrofitted to house the video on demand system. The control electronics are then coupled to each individual video on demand module throughout the cabin by a star network, with separate data wires running between each individual module and the control electronics.

A safety video or demonstration is required to be performed for the passengers on an aircraft before the aircraft takes off. This safety demonstration is required by U.S. Federal law and provides instructions to the passengers regarding procedures to be followed in the event of an emergency. On smaller aircraft equipped for shorter flights, the text of this safety demonstration is read over the airplane's intercom system by one of the airline's staff, while other members of the staff demonstrate necessary functions of the airplane's safety and exit equipment for the passengers. On bigger airplanes equipped with video screens or monitors, a safety video is played for simultaneous viewing by all of the passengers. This safety video is prerecorded and includes the same required text and illustrations as the live safety demonstration. Sometimes, the flight attendants, in conjunction with the safety video, will also perform live equipment demonstrations during the playing of the video. Accordingly, it is important that all passengers are viewing the safety video simultaneously.

What is needed is a video on demand in-flight entertainment system which is fully interactive and can provide multiple features to a passenger through an individual module. What is further needed is a video on demand in-flight entertainment system which uses complete end-to-end digital delivery from the control system to the passenger seat units and also includes an overhead broadcast system. What is still further needed is a video on demand in-flight entertainment system which provides all entertainment features on demand to all passengers having access to a passenger seat unit at all authorized times. Additionally, what is needed is an in-flight entertainment system which incorporates a serial network and is therefore lighter, easier to maintain and

easier to reconfigure than existing systems. What is also needed is an in-flight entertainment system which includes separate and redundant systems allowing a portion of the system to fail without rendering the entire system nonoperational.

SUMMARY OF THE INVENTION

An in-flight passenger entertainment system has a first digital network for communication among components of a headend system including a data server, media controller, one or more media servers, system interface unit, system manager unit and attendant control panel. The in-flight entertainment system is coupled to an aircraft's existing systems through the system interface unit and the system manager unit. The components of the headend system are all coupled to a network switch for routing data within the first network. The network switch is also coupled to one or more zone bridge units, each of which is coupled to multiple seat electronics units. The zone bridge units and the seat electronics units together form a second digital network. The first digital network is preferably an ATM network with fibre optic cables used to carry the data. The second digital network is preferably an IEEE 1394 serial bus network. The zone bridge units control all communications between the networks, converting all communications into the format required by the respective network. All communications across the networks are transmitted as digital data and when necessary are converted to analog signals at the seat electronics units. Through passenger control sets coupled to the seat electronics units, a passenger has access to audio and video on demand, video games, gambling, telephone service and information services. A passenger also has the ability to fast forward, rewind and pause a video feature. An overhead audio and video distribution system is used to provide audio and video content as a backup to the video on demand system or as an alternative subsystem in zones of the aircraft in which there are passenger control sets with less than full capability. A first audio path for transmitting audio content from the headend system is routed to predetermined seat entertainment units through the network switch and the zone bridge units. A second audio path for transmitting audio from the system interface unit is routed to the seat entertainment units through the zone bridge units.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a system block diagram of a digital video on demand and backup broadcast distribution system of the present invention.

FIG. **2** illustrates the interface couplings between the in-flight entertainment system **200** of the present invention and the aircraft's existing systems.

FIG. **3** illustrates a detailed block diagram of the components within the preferred embodiment of the media server units.

FIG. **4** illustrates a detailed block diagram of the components within the preferred embodiment of the media controller and the data server.

FIG. **5** illustrates a detailed block diagram of the components within the preferred embodiment of the system manager unit.

FIG. **6** illustrates a detailed block diagram of the preferred functional components and connections of the system manager unit and the attendant control panel.

FIG. **7** illustrates a detailed block diagram of the preferred embodiment of the system interface unit.

FIG. **8** illustrates a block diagram of the preferred embodiment of the ATM switch circuit.

FIG. **9** illustrates a block diagram of the preferred embodiment of the zone bridge unit.

FIG. **10** illustrates a block diagram of a triple seat electronics unit.

FIG. **11** illustrates a block diagram of a preferred embodiment of a passenger set of seat peripherals.

FIG. **12** illustrates an audio distribution path configuration within the in-flight entertainment system of the present invention.

FIG. **13** illustrates an alternate audio distribution path configuration.

FIG. **14** illustrates an alternate subsystem audio distribution path configuration.

FIG. **15A** illustrates a block diagram of a subsystem of the present invention without video on demand capabilities.

FIG. **15B** illustrates the additions to the subsystem of FIG. **15A** which are required to provide video on demand within the system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An in-flight entertainment system includes a headend system having a data server, a media controller, one or more media servers, a system interface unit, a system manager unit and an attendant control panel. The components of the headend system are coupled together for communications by a digital ATM network. Preferably, fibre optic cables are used to form the ATM network. The components of the headend system are all coupled, through the ATM network, to an ATM network switch, for routing data within the network. The network switch is also coupled to one or more zone bridge units. Each of the zone bridge units is coupled to multiple seat electronics units. Each seat electronics unit is coupled to control one or more passenger control sets through which passengers on the aircraft access the in-flight entertainment system of the present invention. The zone bridge units and the multiple seat electronics units are coupled together by an IEEE 1394 serial bus network. All communications across both of the networks are transmitted as digital data and when necessary, are converted to analog signals at the seat electronics units.

The in-flight entertanment system is coupled to the aircraft's existing systems through the system interface unit and the system manager unit. An overhead audio and video distribution system, controlled by the system interface unit, is used to provide audio and video content as a backup to the ATM/1394 network and as an alternate subsystem in zones of the aircraft in which there are passenger control sets with less than full capability. Audio and video content data for use at the seat electronics units is stored and delivered from the media servers. When requested by a passenger, this audio and video content data is transmitted from the media servers, over the ATM network to the appropriate zone bridge unit. This transmission is controlled by the media controller at the headend of the system. From the zone bridge unit, the data is then transmitted over the IEEE 1394 serial bus to the appropriate seat electronics unit. Through each passenger control set of seat peripherals, a passenger has access to audio and video on demand, video games, gambling, telephone service and information services, such as the airline's flight schedule. When utilizing the video on demand features, a passenger also has the ability to fast forward, rewind and pause a video feature.

Within the in-flight entertainment system of the present invention, data is collected, stored and arranged in data sets, in a conventional manner. It should be understood that, as used herein, data sets can include audio data, video data or both audio and video data, game information, purchasing information, gambling information, software and control data. It should also be understood that, as used herein, data sets can also include any other appropriate collection of data.

Dual audio distribution paths are maintained from the headend system to the seat electronics units. A first audio distribution path is routed from the headend servers through the ATM network switch to the zone bridge units. From the zone bridge units, the first audio path is then distributed to the seat electronics units. The first audio distribution path is used for the distribution of audio content from the media servers. A second audio distribution path is routed from the system interface unit to the zone bridge units and then to the seat electronics units. The second audio distribution path is used for the distribution of audio for public address announcements and for overhead entertainment audio. The second audio distribution path is provided to all of the seat electronics units. The first audio distribution path is provided to seat electronics units within selected zones where the audio and video on demand features of the in-flight entertainment system are available. As will be described below, an alternate embodiment of the present invention also allows a subsystem to be implemented with only the second audio distribution path. This subsystem can then be upgraded to include the first audio distribution path in those zones of the aircraft including video on demand features.

A system block diagram of an in-flight entertainment system including a digital video on demand and backup broadcast distribution system of the present invention is illustrated in FIG. 1. Headend servers **100** of the system include a data server **102**, a media controller **104** and multiple media servers **106** and **108**. The data server **102** includes a hard disk drive which stores and transmits data necessary for playing video games at a passenger's seat electronics unit and also maintains the data and statistics related to the amount of money and time spent on different features at each individual passenger seat.

The media controller **104** preferably includes a hard disk drive and is responsible for the scheduling of continuous media streams from the headend servers **100** to the seat electronic units, loading of content to the media servers **106** and **108** and control of trick mode operation at each individual seat electronic unit. The trick mode operation includes the rescheduling of a data stream when a passenger sends fast forward, rewind, pause or stop instructions while viewing a video feature.

Each of the media servers includes one or more hard disk drives and stores data to support the video on demand and audio on demand features of the system, including data representing feature films and audio content. The number of media servers necessary is dependent upon both the content storage requirements and the number of simultaneous streams of data supported by the system. Constant bit rate, isochronous intervals are used to distribute data from the media servers **106** and **108** through the seat electronics units to the passenger sets of seat peripherals. The data server **102**, the media controller **104** and the media servers **106** and **108** are all coupled to an asynchronous transfer mode (ATM) network switch **116**, preferably by fibre optic cables.

A system manager unit **114** is also coupled to the ATM switch **116**, preferably by a fibre optic cable. The system manager unit **114** is coupled to an attendant control panel **110** for receiving data from and providing data to a system attendant. The attendant control panel **110** is coupled to a set of input/output devices **112**, including a display, a keyboard, a printer and a credit card reader. For purposes of this document, the term credit card reader will be understood to include smart card reader where appropriate. The system manager unit **114** provides the interface to the attendant control panel **110**. The system manager unit **114** also includes a computer, for entering data into and reading data from the video on demand system, which is accessed through conventional electronic media readers such as a floppy disk drive, CD Rom drive or a magnetic tape drive. Content data for the video on demand system is loaded through the system manager unit **114** and decrypted before being stored on the appropriate one of either the data server **102**, the media controller **104** and the media servers **106** and **108**.

Data is provided to and extracted from the system through this computer. The system manager unit **114** also provides an interface to the aircraft's navigational system (NAV) and to an airline communication addressing response system (ACARS), which allows air to ground communication between the aircraft and the airline. The system manager unit **114** further provides an interface to a printer for extracting data reports and receipts from the system in printed form. The system manager unit **114** is also coupled to receive, generate and monitor keyline control signals for monitoring conditions of the airplane such as decompression and weight on the wheels. The system manager unit **114** is also coupled to a first zone bridge unit **138** for monitoring and controlling communications relating to the passenger service system (PSS).

A system interface unit **118** is also coupled to the ATM switch **116**, preferably by a fibre optic cable. The system interface unit **118** is coupled to the aircraft's conventional entertainment system and drives the overhead display system including overhead video monitors and audio system, as will be described below. This overhead audio system a public address (PA) audio system. The system interface unit **118** and the overhead video monitors and audio system together provide an alternate and backup broadcast system which allows the airline flexibility in the design of the interior of the airplane's cabin and a backup system in the event of a failure of the video on demand entertainment system. The system interface unit **118** is coupled to an audio reproducer unit **120**, which preferably includes a compact disk player with multiple compact disks containing audio data. The system interface unit **118** is also coupled to one or more video reproducer units **122**, which each preferably include a video cassette player and the ability to output video content from inserted video cassettes. The video reproducer units **122** could also include one or more video disk players.

The system interface unit **118** is also coupled to the aircraft's public address audio system **124**, over which the pilot, crew and flight attendants of the airplane can address the passengers. The system interface unit **118** implements an override condition which overrides any other audio content being presented to the passengers when the pilot or crew is using the PA audio system. The system interface unit **118** further provides a camera interface **126** to a camera which is mounted to the outside of the airplane and used for observation of certain aspects of the airplane's flight, such as takeoff and landing. Multiple smart video distribution units (SVDU) **128** and **134** are coupled to the system interface unit **118** in a daisy-chain configuration for controlling overhead video monitors **130** and **132**, which may be LCDs as shown or any other substantially flat, light-weight display, or

a projection system **136**, depending on the configuration of the airplane. The system interface unit **118** is also coupled to receive an external audio/video input. The system interface unit **118** is further coupled to the first zone box unit **138**.

The smart video display units **128** and **134** distribute video from the system interface unit **118** at the headend to the overhead displays **130** and **132** or a display system **136**. The smart video display units **128** and **134** also provide power and display controls to the display system **136** and the overhead displays **130** and **132**. The display system can be either a projection system or monitor depending on the configuration of the aircraft.

The data server **102**, media controller **104**, media servers **106** and **108**, system management unit **114**, attendant control panel **110** and system interface unit **118** are all components of the headend control system **101**. Together, these components provide centralized storage of content, control of content delivery, system code storage, data storage, aircraft system interfaces, attendant station functions, network administration, maintenance management, billing services, live audio/video distribution and overhead audio/video generation and control.

Each of the zone bridge units **138** and **140** are coupled to the ATM switch **116**, preferably by fibre optic cables. In addition, the zone bridge units **138** and **140** are coupled to one another, preferably by IEEE 1394 standard digital cables. Likewise, the zone bridge units **138** and **140** are coupled to a predetermined set of seat electronics units, preferably via an IEEE 1394 serial bus network. An IEEE 1394 serial bus network is therefore formed between the zone bridge units **138** and **140** and their respective seat electronics units for communicating with the system manager unit **114** and receiving data from the headend servers **100** through the ATM switch **116**. Each zone bridge unit is coupled to the ATM switch **116** and to control multiple seat electronics units, including providing power and data to and from the seat electronics units. In the system of the preferred embodiment, each zone bridge unit is configured to control up to 50 seat electronics units. For illustration purposes, only a portion of the configuration of the zone bridge unit **140**, relative to specific seat electronics units within its zone, is illustrated in FIG. **1**. It should be readily understood, that the remaining zone bridge units within the system and the remaining seat electronic unit ports of the zone bridge unit **140** will include similar configurations.

The zone bridge unit **140** is coupled to a repeater **144**. The repeater **144** is coupled to a triple seat electronics unit **146**. The triple seat electronics unit **146** is coupled to control and provide data to three sets of seat peripherals **150**, **152** and **154**. The triple seat electronics unit **146** is further coupled to a double seat electronics unit **148**. The double seat electronics unit **148** is coupled to control and provide data to two sets of seat peripherals **156** and **158**. The double seat electronics unit **148** is coupled to one or more additional seat electronics units **149**, depending on the exact configuration of the aircraft. This exact configuration is representative only. Combinations of triple seat electronics units **146** and double seat electronics units **148** are used to cover numerous configurations of seats within the airplane's cabin, to allow an airline maximum flexibility to configure each individual aircraft.

Each set of seat peripherals **150**, **152**, **154**, **156** and **158** include a seat video display, a passenger control unit and a passenger control handset and together with the controlling seat electronics unit effectively implement a personal computer, including internal memory, which receives content data based on the passenger's request, over the IEEE 1394 serial bus network. As will be described in detail below, communications between the seat electronics units, within this zone, and other components within the system are all transmitted using digital data through the ATM network switch **116** and the zone bridge unit **140**. The seat electronics units then convert the digital data to analog data as necessary.

The zone bridge unit **140** is also coupled to a telephone interface circuit **160**. Each telephone interface circuit **160** is coupled to a communications telephone unit **162**, through which a passenger is connected to the aircraft's telephone system and is able to make an air to ground telephone call. Each of the passenger control handsets include a telephone handset. In the preferred embodiment, ten simultaneous telephone calls are permitted within a zone having 50 seat entertainment units.

The ATM switch unit **116** and the zone bridge units **138** and **140** together form a network distribution system **103**. The network distribution system provides for and controls the delivery of data, such as stored content, code, application data, live content and control data, from the servers of the headend control system to the seat electronics units. The network distribution system also provides for and controls the delivery of data, such as, but not limited to, switch data, billing data and game data, from the seat electronics units to the servers of the headend control system. Between each of the components of the headend control system and the ATM switch **116**, data is preferably transmitted in a digital format through fibre optic cables. Between each of the zone bridge units **138** and **140** and their respective seat electronics units **146** and **148**, data is transmitted in a digital format through IEEE 1394 standard cables. Accordingly, an ATM network is formed between the components of the headend control system, the ATM switch **116** and the zone bridge units **138** and **140**, while an IEEE 1394 serial bus network is formed between each zone bridge unit **138** and **140** and the seat electronics units to which it is coupled.

Data transmitted from the headend control system to the seats is sent over the ATM network, through the ATM switch **116** to the proper zone bridge unit **138** and **140**, where it is adapted to the IEEE 1394 format and delivered to the proper seat electronics unit over the IEEE 1394 serial bus. Data sent from the seat electronics units to one of the headend servers or to the system manager unit travels over the IEEE 1394 serial bus to the appropriate zone bridge unit where it is adapted to the ATM network, sent to the ATM switch **116** and routed to the proper headend server. The IEEE standard, "P1394 Standard For A High Performance Serial Bus," Draft 8.01v1, Jun. 16, 1995, is an international standard for implementing an inexpensive high-speed serial bus architecture which supports both asynchronous and isochronous format data transfers.

The passenger set of seat peripherals each provide passenger video display and audio listening capability. Each passenger is provided a control interface that includes a passenger control unit and preferably a handset. The passenger control handset preferably includes a telephone handset, a game controller, a content selection device and a credit card reader. The game controller provides an enhanced game interface. The credit card reader allows entry of billing information and provides security of payment for services and entertainment enjoyed by the passenger. While preferably the audio listening capability is provided through a conventional audio headset, alternatively, this capability can also be provided through a noise cancelling headset. Also, while preferably an LCD display is included within a

passenger set of seat peripherals, other types of relatively light weight and relatively high brightness and definition displays are acceptable for use with the present invention, including, for example, goggle-type LCD displays such GLASTRON™ sold by Sony Corporation, Tokyo Japan.

The in-flight entertainment system of the present invention is designed to allow adaptability and flexibility in the configuration and design of the aircraft's cabin. The inclusion of the system interface unit **118**, which interfaces to the overhead portion of the entertainment system allows the overhead system to be used in conjunction with or as a backup to the on-demand portion of the entertainment system of the present invention. This flexibility allows for the use of the video on demand entertainment system in one or more classes or zones of seats within the cabin and the use of the conventional overhead entertainment system in the remaining classes or zones of seats. Also, in the event of failure of the on-demand portion of the entertainment system, the overhead entertainment system is used as a backup to provide entertainment and other content features to the passengers.

In an alternate embodiment, illustrated in the block diagram of FIG. **15A**, only an overhead subsystem is implemented. This subsystem includes only the components necessary to provide entertainment through the overhead portion of the system. These components include the data server unit **102**, the system manager unit **114**, the system interface unit **118**, the audio reproducer unit **120** and the attendant control panel **110**, within the headend system **101**. The subsystems also include the ATM switch **116**, the zone bridge units **140**, the seat electronics units **146** and the smart video display units **128** and **134** with either overhead monitors **130** and/or overhead projectors **136**. In the implementation of this subsystem, each passenger set of seat peripherals includes only a passenger control unit **1104**.

The modifications necessary to upgrade the subsystem of FIG. **15A** to a full video on demand system, according to the present invention, are illustrated in FIG. **15B**. These modifications are shown outlined in solid lines, while the components already included within the subsystem are shown in dotted lines. Within the headend system **101**, these modifications include the addition of one or more media server units **106** and **108**, and the addition of control boards within the data server unit **102**, and MPEG encoder and decoder boards within the system interface unit **118**. Within the ATM switch unit **116**, the addition of network module boards is also required. A zone bridge module must also be added to each zone bridge unit **138**. Each passenger set of seat peripherals must be upgraded to include the display unit **1102** and the passenger control handset **1108**. Each seat electronics unit must be upgraded to include a daughter board. With these modifications, a subsystem, as illustrated in FIG. **15A**, can be upgraded to a full video on demand system, as illustrated in FIG. **15B**.

The interface couplings between the in-flight entertainment system **200** of the present invention and other existing systems within the aircraft are illustrated in FIG. **2**. The aircraft system and headend interface **202** is coupled to the in-flight entertainment system **200** by multiple audio signal lines, including the public address audio signal lines, the audio output from the video reproducer units and prerecorded announcement and boarding music (PRAM) audio. The aircraft system and headend interface **202** is also coupled to the in-flight entertainment system **200** by headend interface signals including public address related discrete control signals, decompression signals, configuration data signals, airplane mode signals and airplane operational discrete signals. A passenger service system (PSS) zone box **204** is coupled to the in-flight entertainment system **200** for communication of control signals related to the passenger service system. Signals from the aircraft's navigational system **206** are coupled to the in-flight entertainment system **200**. The aircraft's operating maintenance system **208** is coupled to the in-flight entertainment system **200** for providing communications related to the maintenance of the aircraft. The airline communication addressing response system (ACARS) **210** is also coupled to the in-flight entertainment system **200** for providing air to ground communications between the airline and the aircraft. The aircraft's cabin telecommunications unit **212** is also coupled to the in-flight entertainment system **200** for linking the telephone handsets at the seat electronics units to the aircraft's telephone system, thereby allowing passengers to make air to ground telephone calls from the aircraft, through a link to a satellite or through radios to the ground.

A detailed block diagram of the components within the media server units **106** and **108** is illustrated in FIG. **3**. A preferred media server is the Microsoft Media Server, available from Microsoft of Redmond, Wash. A control processor **300** is coupled to a data bus **302** for controlling communications and providing instructions within the media server unit. The data bus **302** may be configured as a Peripheral Component Interconnect (PCI) bus, an Industry Standard Architecture (ISA) bus or any other appropriate type of data bus. The control processor **300** is also coupled to a system hard drive **306**, an internal random access memory (RAM) **304** and a temperature sensor which includes a fan control circuit **310**. The temperature sensor and fan control circuit **310** is coupled to one or more fans **312** for controlling the temperature within the media server unit. The data bus **302** is coupled to an ATM network adapter **308**. The ATM network adapter **308** is coupled to the ATM switch **116** for communicating over the ATM network with other components within the system. Preferably, the ATM network adapter **308** is coupled to the ATM switch **116** by an OC3 fibre optic cable. Alternatively, any appropriate link can be used to couple the ATM network adapter **308** and the ATM switch **116**. The data bus **302** is also coupled to one or more content disk drive adapters **318**. Each content disk drive adapter **318** is coupled to one or more content disk drives **320** for storing data in and obtaining data from each of the content disk drives **320**. The content disk drives **320** store audio and video content data to be accessed through the seat electronics units. A 115 volt, 400 Hertz, AC power line and a power disable keyline control signal are coupled to a power supply control circuit **314**. The temperature sensor and fan control circuit **310** is also coupled to the power supply control circuit **314**. The power supply control circuit **314** is coupled to a power supply circuit **316**. The power supply circuit **316** is coupled to the temperature sensor and fan control circuit **310** and to the data bus **302** for providing power to the circuits within the media server unit.

A detailed block diagram of the components within the media controller server **104** and the data server **102** are illustrated in FIG. **4**. Within the preferred embodiment of the present invention, the media controller server **104** and the data server **102** are implemented within a single line replaceable unit. The data server unit **102** includes a control processor **400** which is coupled to a data bus **402** for controlling communications and providing instructions within the data server unit **102**. The control processor **400** is also coupled to an internal RAM **408** and a system hard drive **404**. The system hard drive **404** is coupled to a mirror hard drive **406** for providing redundancy and backup data.

The data bus **402** is also coupled to an ATM network adapter **410**. The ATM network adapter **410** is coupled to the ATM switch **116** for communicating over the ATM network. Preferably, the ATM network adapter **410** is coupled to the ATM switch **116** by an OC3 fibre optic cable. Alternatively, any appropriate link can be used to couple the ATM network adapter **410** and the ATM switch **116**.

A control processor **420** is coupled to a data bus **422** for controlling communications and providing instructions within the media controller unit **104**. The control processor **420** is also coupled to an internal RAM **428** and a system hard drive **424**. The system hard drive **424** is coupled to a mirror hard drive **426** for providing redundancy and backup data. In addition, the data bus **422** is coupled to an ATM network adapter **430**. The ATM network adapter **430** is coupled to the ATM switch **116** for communicating over the ATM network with other components within the system. Preferably, the ATM network adapter **430** is coupled to the ATM switch **116** by an OC3 fibre optic cable. Alternatively, any appropriate link can be used to coupled the ATM network adapter **430** and the ATM switch **116**.

A 115 volt, 400 Hertz, AC power line and a power disable keyline control signal are coupled to a power supply control circuit **416**. The power supply control circuit **416** is coupled to a power supply circuit **418**. The power supply circuit **418** is coupled to the data bus **402**, to the data bus **422** and to a temperature sensor and fan monitor circuit **412** for providing power to the circuits within the line replaceable unit including the data server unit **102** and the media controller unit **104**. The temperature sensor and fan monitor circuit **412** is coupled to the control processor **400**, to the control processor **420** and to one or more fans **414** for controlling the temperature within the line replaceable unit. The temperature sensor and fan monitor circuit **412** is coupled to the power supply control circuit **416** to control the power if excessive temperature is detected.

A detailed block diagram of the components within the system manager unit **114** is illustrated in FIG. **5**. A control processor **500** is coupled to a backplane **502** through a data bus **510** for controlling communications and providing instructions to the components within the system manager unit **114**. A power supply circuit **504** is also coupled to the backplane **502** for providing power to the components within the system manager unit **114**. A power control circuit **519** is coupled to the power supply **504** and to the control processor **500**, through the printer port **518**. The control processor **500** is coupled to an internal RAM **506**, a system hard drive **508** and a floppy disk drive **512**. The control processor **500** is also coupled to a keyboard **524**, through a keyboard interface circuit **522**, to a maintenance port **208**, through a RS-232 interface **516**, and to a touch screen panel in a display **536**, through a RS-232 interface **514**. The backplane **502** is also coupled to an ATM network interface **526** by a PCI bus **528**. The system manager unit **114** is coupled to the ATM switch **116** through the ATM network interface **526** for communications over the ATM network. The backplane **502** is also coupled to an MPEG video graphics adapter (VGA) interface **530** by a PCI bus **532**. The MPEG VGA interface **530** is coupled to the system interface unit **118** for receiving audio and video input from the system interface unit. The MPEG VGA interface **530** is also coupled to the display **536** and to a set of audio headphones, through a display, headphone interface circuit **534** for communicating with an attendant.

The backplane **502** is further coupled to an Arinc **429** standard interface circuit **540**, through an ISA bus **542**, for communication with the systems within the aircraft, including the operational maintenance system, the navigational computer and the ACARS. The backplane **502** is also coupled to a RS-232 interface circuit **544**, through an ISA bus **546**, for communication with components of the attendant control panel **110**, including a credit card and a receipt printer **520**. The backplane **502** is also coupled to an Arinc **485** standard interface circuit **548**, through an ISA bus **550**, for communication with a cabin passenger management system (CPMS), a secondary attendant station, the aircraft's headend system and the passenger service system. The backplane **502** is also coupled to a power control keyline circuit **552**, through an ISA bus **554**, for providing power to disable keyline signals and coupling to other input/output keyline signals. The backplane **502** is further coupled to a SCSI-2 interface circuit **556**, through a PCI bus **558**, for coupling to and receiving data from a tape drive **560**.

A detailed block diagram of the functional components and couplings of the system manager unit **114** and the attendant control panel **110** is illustrated in FIG. **6**. The system manager unit **114** includes multiple input/output devices, including a magnetic tape reader **606**, a floppy disk drive **512** and a SCSI content loading interface **556** to which a tape drive or multiple tape drives can be connected to input content data to the in-flight entertainment system or to read data from the in-flight entertainment system. The attendant control panel **110** also includes multiple input/output devices, including a CD Rom drive **604**, a credit card reader **602**, one or more printers **520**, a headphone port **538**, a display **536** and a keyboard port **524**. The keyboard which is coupled to the keyboard port **524** will preferably include an integral pointing device, such as a trackball, mouse or 'eraser head'. The credit card reader **602** allows attendants to read a passenger's credit card directly at the attendant station. Preferably, the credit card reader is part of the attendant control panel **110**. A credit card receipt printer is used by an attendant to print a credit card receipt when a credit card is used by a passenger or entered by an attendant.

The display **536** is used by the attendant for menu navigation, through finction or task menus, on the attendant control panel **110** and for movie previews. Preferably, the display **536** is a ten inch, liquid crystal display, having a resolution of 640x480 and incorporating active matrix color display technology. Additionally, the preferred embodiment of the display **536** includes a touch screen interface and function keys.

Content data, such as updated feature films and audio content, is loaded from a tape unit, onto the media servers **106**, through the SCSI content loading interface **556** or the magnetic tape drive **606**. This loading of content data onto the media servers is preferably performed while the aircraft is at the terminal being serviced. In this manner, an airline can maintain a portable tape drive system which is brought out to each aircraft during routine servicing, in order to update the content available through the in-flight entertainment system of the present invention. Preferably, the tape unit interface supports a minimum read throughput of 1.5 megabytes per second and the tape unit is SCSI-2 fast compatible. Alternatively, the system will include multiple tape unit interfaces, providing for concurrent loading of content data from multiple tape units. It should also be noted that the system of the present invention preferably, only allows content data to be uploaded into the system. In order to protect proprietary content programming and prevent unauthorized copying by unscrupulous persons, content data cannot be downloaded from the preferred embodiment of the system of the present invention.

Control data, used to configure and control the in-flight entertainment system, is loaded into the system through

floppy disks read by the floppy disk drive **512** or through CD Roms read by the CD Rom drive **604**. Preferably, the floppy disk drive **512** and the CD Rom drive **604** support a minimum read throughput of 500 kilobytes per second. Alternatively, control data can be loaded using any other available means, including an electronic data link.

A detailed block diagram of the system interface unit **118** is illustrated in FIG. **7**. A control processor **700** including memory is coupled to both a PCI bus **724** and an ISA bus **726** for communicating with the other components within the system interface unit **118**. A hard disk drive **702** is also coupled to the control processor **700**. A keyline interface circuit **706** is coupled to the ISA bus **726** to receive and send keyline control signals. An ATM network interface **704** is coupled to the ATM switch **116** and to the PCI bus **724**, thereby allowing the system interface unit **118** to communicate over the ATM network. A first audio/video multiplexer **712** is coupled to receive both video and audio data from one or more video cameras positioned on the aircraft, the passenger flight information system, one or more video reproducer units and television signals. The first audio/video multiplexer **712** is also coupled to an MPEG encoder circuit **714** and to the ISA bus **726**. The MPEG encoder circuit **714** is coupled to the PCI bus **724**. A second audio/video multiplexer **710** is coupled to provide video signals to the one or more smart video distribution units and audio signals to a multiplexed audio interface. The second audio/video multiplexer **710** is also coupled to receive public address system audio signals. The second audio/video multiplexer **710** is further coupled to the first audio/video multiplexer **712**, to an MPEG decoder circuit **708** and to the ISA bus **726**. The MPEG decoder circuit **708** is coupled to the PCI bus **724**. A power control and power supply circuit **716** is coupled to receive power control keyline signals and to provide power to the components within the system interface unit **118**. An elapsed time indicator circuit **718** is coupled to the power control and power supply circuit **716**, to a display **720** and to the ISA bus **726**. An RS-485 standard interface circuit **722** is coupled to communicate with the video reproduce units, cameras and smart video distribution units. The RS-485 standard interface circuit **722** is also coupled to the ISA bus **726**. The interfaces that are discussed above are explanatory only, and are related to the new standard aircraft interface. It will be apparent to one of ordinary skill in the art that other appropriate interfaces could be included.

A block diagram of the ATM switch circuit **116** is illustrated in FIG. **8**. A switch backplane **800** is coupled to one or more switch control processors **802**. Each switch control processor **802** is coupled to one or more network modules **808**, which each include multiple ATM network ports through which communications are transmitted and received. Each ATM port interfaces with an ATM network interface within a component of the system for directing communications over the ATM network. Each network module **808** preferably includes four ATM ports. The switch control processor **802** is also coupled to an RS-232 serial port **804**. Alternatively, each switch control processor **802** is coupled to an ethernet port **806**. A power control keyline signal is coupled to a power control circuit **812**. The power control circuit **812** is coupled to a dual redundant power supply circuit **810**. The power supply circuit **810** is coupled to receive a 115 volt AC, 400 Hertz, power line signal. The power supply circuit **810** is also coupled to the switch backplane circuit **800** for providing power to the components within the ATM switch circuit **116**. A preferred ATM switch is available from Fore Systems of Warrendale, Pennsylvania. Alternatively, any appropriate ATM switch can be implemented.

The ATM switch **116** is the in-flight entertainment system's central switching fabric for the headend control system's ATM network. The ATM switch **116** is used for data switching between the components of the headend control system and the zone bridge units. The ATM switch **116** is also used for switch call processing and switch maintenance processing. The ATM switch **116** further provides power supply redundancy through the dual redundant power supply circuit **810**.

A block diagram of a zone bridge unit is illustrated in FIG. **9**. An optical receiver link **902** is coupled to the ATM network for communicating over the network. Preferably, the optical receiver link **902** is coupled to the ATM network by an OC3 fibre optic cable. Alternatively, any appropriate link can be used to couple the optical receiver link **902** to the ATM network. The optical receiver link **902** is coupled to an ATM segmentation and reassembly (SAR) device **904**. The ATM SAR **904** is coupled to a control processor **906**, to a memory circuit **908** and to a network link circuit **910** for communicating between the ATM network and the seat network. The network link circuit **910** is coupled to the seat network through a physical interface circuit **912** and for sending data to and receiving data from the seat electronic units within the zone. Overhead audio data is provided to the seat network through a buffer **914** within the zone bridge unit. A universal asynchronous receiver transmitter (UART) **916** is coupled to the passenger service system. The UART **916** is coupled to a control processor **920**, to a memory circuit **922**, to a digital signal processor **924** and to a buffer **918** for controlling communications between the passenger service system and the seat network. The buffer **918** is coupled to a combining circuit **926**. Preferably, a CEPT-E1 standard circuit **930** is coupled to the aircraft's telephone system. The CEPT-E1 circuit **930** is coupled to the digital signal processor **924** and to a buffer **928** for controlling telephone communications from within the zone. Alternatively, any appropriate telecommunications link can be coupled to the aircraft's telephone system. The buffer **928** is coupled to the combining circuit **926**. The combining circuit **926** is coupled to the seat network for controlling communications to and from the aircraft's passenger service system and telephone system.

A 115 volt, 400 Hertz, AC power line and a power disable keyline control signal are coupled to a power control circuit **940**. The power control circuit **940** is coupled to the power supply circuit **942**. The power control circuit **940** is coupled to seat electronics units within the zone for providing power signals to the seat electronics units.

Each of the zone bridge units bridge the high speed, fibre optic ATM network at the headend of the system to the IEEE 1394 serial bus seat distribution network for a particular zone within the aircraft. The zone bridge unit is responsible for managing the IEEE 1394 seat distribution network for a zone within the aircraft including the functions of IEEE 1394 bus management and IEEE 1394 bandwidth resource management. The zone bridge unit is further responsible for mapping IEEE 1394 addressing to ATM addressing as well as supporting broadcast and multicast functionality between the ATM network and the IEEE 1394 seat distribution network.

A block diagram of a triple seat electronics unit is illustrated in FIG. **10**. A peripheral interface **1000** is coupled to a system EEPROM **1002**, to a buffer circuit **1004**, to a buffer circuit **1012**, to a passenger control unit for each of the three seat electronics units, to a video display bus and to a passenger service system, passenger address and telephone bus. The buffer circuit **1004** is coupled to a configuration

EEPROM **1010**, a RAM **1006** and a microcontroller circuit **1008**. The buffer circuit **1012** is coupled to an ISA bus **1014** for each seat electronics unit controlled by the triple seat electronics box. The ISA bus **1014** for each seat electronics unit is coupled to a control processor/system DRAM, memory controller and bus bridge circuit **1016**. The ISA bus **1014** for each seat electronics unit is also coupled to a MPEG decode and DRAM circuit **1020** and to an audio synthesizer **1022**, including a wavetable ROM and audio DRAM. A graphics controller circuit **1018** is coupled between the control processor/system DRAM, memory controller and bus bridge circuit **1016** and the MPEG decode and DRAM circuit **1020**. While, a triple seat electronics unit has been illustrated in FIG. **10** for explanatory purposes, it should be apparent to those skilled in the art that a seat electronics unit could be implemented to provide an interface to any number of passenger sets of seat peripherals.

Each seat electronics unit provides the passenger electronics necessary to fully interface the features of the in-flight entertainment system of the present invention with the passenger at the seat. A block diagram of a seat electronics unit and accompanying peripherals is illustrated in FIG. **11**. The seat electronics unit **1100** is also coupled to up to three displays **1102** for providing video and graphics images to the passenger. Preferably, the display **1102** is an LCD. Alternatively, other types of relatively light weight and relatively high brightness and definition displays are acceptable for use with the present invention, including, for example, goggle-type LCD displays such GLASTRON™ sold by Sony Corporation, Tokyo Japan. The seat electronics unit **1100** is further coupled to up to three passenger control units **1104**. The passenger control unit **1104** includes a modem jack to which a passenger's personal computer can be coupled. A headset **1106** is coupled to the passenger control unit **1104** for providing audio content to the passenger. While a conventional audio headset is preferred for use as the headset **1106**, the audio headset **1106** can alternatively be a noise cancelling headset which includes a power connection to the headset in addition to the audio connections. A personal control handset **1108** is also coupled to the passenger control unit **1104**. The personal control handset **1108** is coupled to the passenger control unit **1104** by a cord which is stored within and extends from the seat arm. A preferred passenger control handset **1108** includes an integral game controller, telephone handset and credit card reader. For additional details on one suitable embodiment of the passenger control handset **1108**, see U.S. Pat. No. 08/639,287, filed on Apr. 25, 1996 and entitled An Integrated Electronic System Utilizing A Universal Interface To Support Telephone And Other Communication Services. The passenger control handset **1108** is used by the passenger to enter commands and data into the system. The seat electronics unit **1100** is coupled to the neighboring seat electronics units **1112** and **1114**.

The seat video display **1102** provides the passenger with an LCD display for viewing personal entertainment data and information service data at their seat. Preferably, the seat video display **1102** is housed within a stowable seat display arm which is rotated out when in use and stored within an arm rest when not in use. Alternatively, the seat video display **1102** is located within the seatback or bulkhead in front of the passenger's seat. The viewing angle, high brightness and high contrast are characteristics which can be adjusted by a user in the preferred embodiment of the seat video display **1102**. The data received by the seat electronics unit **1100**, over the IEEE 1394 bus, is received in a digital format. Accordingly, the seat electronics unit **1100** includes one or more digital-to-analog converter circuits for converting the received digital data stream, representing the video and audio, to an analog data stream before it is transmitted to either the display **1102** or the headset **1106**. While preferably the display is an LCD, other types of relatively light weight and relatively high brightness and definition displays are acceptable for use with the present invention, including, for example, goggle-type LCD displays such GLASTRON™ sold by Sony Corporation, Tokyo Japan. Also, while a conventional audio headset is preferred for use as the headset **1106**, the audio headset **1106** can alternatively be a noise cancelling headset which includes a power connection to the headset in addition to the audio connection.

System configuration data is loaded from the floppy disk drive **512** of the system manager unit **114** or the CD Rom drive **604** of the attendant control panel **110** onto the data server **102**, thereby forming a software configuration database. Once stored onto the data server **102**, the software configuration database is writable to either the CD Rom drive **605** or to the floppy disk drive **512** for troubleshooting. If any configuration data is not loaded, is incorrectly loaded or loading is aborted, an error message will be displayed on the display **536** at the attendant control panel **110**.

The system configuration data includes specific cabin management data, expected system configuration, flight information data and billing system inputs. The specific cabin management data includes the data related to the overhead video selection and audio channel assignments, zone programming assignment and aircraft seat class assignment for the flight. The cabin management data also includes the data relating to customer menus and languages, including a greeting menu which is displayed with the airline's colors and logo. Alternatively, the cabin management data will also include the data for inventory management of meals, drinks and duty free items, as well as system usage statistics.

The expected system configuration data includes the data related to the specific hardware and software in use within the aircraft and the configuration of the hardware, including the number of seats, seat boxes, zones, servers and attendant stations and the specific seat arrangement. The flight information data contains the data on the passengers, including the passenger's names, where each passenger is sitting, their frequent flyer number, whether or not they are flying with a group and their pre-authorized spending account balances on the in-flight entertainment system. The billing system inputs include data on the billing system rates, currency exchange rates for international flights, prices of each product and service, list of free products and services and packages of products and services, an encrypted table of invalid credit card numbers and a list of statistics to be collected on use of the system during the flight.

Using the components of the system manager unit **114** and the attendant control panel **110**, an attendant can obtain information from the in-flight entertainment system including maintenance data, passenger financial account data, passenger transaction log, system hardware and software identification, system content and configuration data, usage statistics, inventory management data and system error log files. This data can be loaded onto removable electronic media such as a floppy disk using the floppy disk drive **512** or onto a magnetic tape using the magnetic tape drive **606**. Alternatively, this data can also be downloaded using an electronic data link. Again, it should be noted that the system of the present invention preferably allows content data to be only uploaded into the system. In order to protect proprietary

content programming and prevent unauthorized copying by unscrupulous person, content data cannot be downloaded from the preferred embodiment of the system of the present invention.

A block diagram showing the audio distribution paths of the entertainment system of the present invention is illustrated in FIG. **12**. The first audio distribution path **1220** is routed from the ATM network switch **116** to the headend servers **100** and to each of the zone bridge units **138, 140** and **1200**. The second audio distribution path is routed from the system interface unit **118** to each of the zone bridge units **138, 140** and **1200**. The first and second audio paths are then routed from the zone bridge units **138, 140** and **1200** to each seat electronics unit within the respective zones.

The first audio path is used to distribute audio content from the media servers **106** and **108** to the seat electronics units. The second audio path is used to distribute audio for the PA system and the overhead system to the seat electronics units. The second audio path is therefore provided to all seat electronics units within the aircraft. The first audio path is provided selectively to zones of the aircraft equipped with the video and audio on demand system. The seat electronics units within zones of the aircraft which are not equipped with the video and audio on demand system are only capable of receiving the audio content from the second audio path. The passengers in these zones will only receive video content from the overhead distribution system. The seat electronics units within zones of the aircraft that are equipped with the video and audio on demand system, are described in detail below, and are capable of receiving audio content from both the first and second audio paths. The seat electronics units within zones of the aircraft equipped with the video and audio on demand system include a display, an audio output, an input device, a telephone handset and a credit card reader, allowing a passenger to have access to audio and video on demand, video games, gambling, telephone service and information services, if implemented in a given embodiment. Seats which only receive audio content from the second path are not equipped with displays, but receive audio content through the second audio path and a set of headphones.

A block diagram showing the selective distribution of the first audio path is illustrated in FIG. **13**. The distribution of the audio paths are as described above in reference to FIG. **12**, with the exception that the first audio path is not provided to the zone **3** bridge unit **140** and the seat electronics units **1214** and **1216** coupled to the zone **3** bridge unit **1204**. In this configuration, only the second audio path is provided to the zone **3** bridge unit **1204** and the seat electronics units **1214** and **1216** within that zone. In this manner, the first and second zones of the airplane, which could be first and business class, are provided with both the first and second audio paths. The third zone of the airplane, which could be economy class, is only provided with the second audio path. The passengers within the third zone will therefore only have access to the PA audio and entertainment audio provided from the system interface unit **118**, while the passengers within the first and second zones will additionally have access to video and audio content from the media servers **106** and **108**, as well as games and interactive services from the data server **102**.

A block diagram showing an implementation of audio distribution within the subsystem of FIG. **15A** without on-demand features is illustrated in FIG. **14**. In this subsystem only the second audio path from the system interface unit **118** to the zone bridge units **138, 140** and **1200** and then to the seat electronics **1206, 1208, 1210, 1212, 1214** and **1216**, is included.

DATA TRANSFERS TO THE SEAT ELECTRONICS UNITS

As described above, an IEEE 1394 network is formed between the zone bridge units and the seat electronics units for the communication of data within the zone. The IEEE standard, "P1394 Standard For A High Performance Serial Bus," Draft 8.01v1, Jun. 16, 1995, is an international standard for implementing an inexpensive high-speed serial bus architecture which supports both asynchronous and isochronous format data transfers. Isochronous data transfers are real-time transfers which take place such that the time intervals between significant instances have the same duration at both the transmitting and receiving applications. Each packet of data transferred isochronously is transferred in its own time period. The IEEE 1394 standard bus architecture provides multiple channels for isochronous data transfer between applications. A six bit channel number is broadcast with the data to ensure reception by the appropriate application. This allows multiple applications to simultaneously transmit isochronous data across the bus structure. Asynchronous transfers are traditional data transfer operations which take place as soon as possible and transfer an amount of data from a source to a destination.

The IEEE 1394 standard provides a high-speed serial bus for interconnecting digital devices thereby providing a universal I/O connection. The IEEE 1394 standard defines a digital interface for the applications thereby eliminating the need for an application to convert digital data to analog data before it is transmitted across the bus. Correspondingly, a receiving application will receive digital data from the bus, not analog data, and will therefore not be required to convert analog data to digital data. Devices can be added and removed from an IEEE 1394 bus while the bus is active. If a device is so added or removed the bus will then automatically reconfigure itself for transmitting data between the then existing nodes. A node is considered a logical entity with a unique address on the bus structure. In the in-flight entertainment system of the present invention each seat electronic unit forms a node on the IEEE 1394 bus within its zone.

The in-flight entertainment system of the present invention provides both multicast and broadcast distribution of data to the seat electronics units in addition to the individualized streams of data supporting the video and audio on demand features. Multicast distribution of data is used to deliver common data, such as video from the observation camera or data from the passenger flight information system, to only those passengers who wish to receive it. Broadcast distribution of data is used to deliver public address announcement audio data and video content such as the safety video simultaneously to all of the seats. The broadcast data has priority over any other transfer of data on the network.

When transmitting the broadcast data, especially the safety video, it is important that all of the passengers within the aircraft receive the data stream simultaneously, in order that the video viewed by each passenger is synchronized to any live demonstrations by the flight attendants. Using the ATM network and the ATM switch **116**, data broadcast through the ATM switch **116** is synchronized by setting up a multipoint to multipoint connection through the ATM switch **116**. The ATM switch **116** combines the time multiplexed data stream coming in on several input ports of the distributed servers within the headend. The ATM switch **116** then copies the data to each output port coupled to a zone bridge unit. Thus, each zone bridge unit only receives a

single copy of the broadcast data stream. The broadcast data stream passes through the zone bridge unit which routes the data to the seat network. The IEEE 1394 seat network then broadcasts this stream of data to each seat on each seat column output of the zone bridge unit. This secondary broadcast from the zone bridge unit uses a point to multipoint broadcast connection technique, with each seat electronics unit only seeing one copy of the data stream. This technique eliminates network bottlenecks and allows the server to broadcast a single data stream over an ATM network to all of the seat electronics units in synchronization. The few copies of the data stream within the network avoids flooding the network with stream copies guaranteeing a low distribution latency for the system. Using this multipoint to multipoint virtual channel connection between the headend servers and the seat electronics units, the entire aircraft can receive the same data stream in synchronization.

OPERATION OF THE VIDEO AND AUDIO ON DEMAND FUNCTIONS

The media controller **104** (FIG. **1**) is responsible for controlling the delivery of video and audio content data from the media servers **106** and **108** to a seat electronics unit. When a passenger selects a program for viewing or listening, a request is sent to the media controller **104**. Once the media controller **104** receives such a request, a play slot is scheduled for the passenger. The media controller **104** then adds the passenger to the play schedule and sends a request to the media servers **106** to output data to the address of the passenger's seat electronics unit. Commands from the passenger, such as stop, pause, fast forward and rewind, are also sent to the media controller **104**, which then modifies the play schedule for that passenger appropriately. The media controller **104** maintains a list of the available content on the media servers **106** and **108** which is updated whenever content on the media servers is changed.

Video content on the media servers is preferably stored in MPEG format, with support for multiple languages and subtitle information. The language or subtitle display is selected by the passenger via on screen menus when the video is initially selected. The content data is stored across multiple media servers. Each media server also stores a portion of each program as a redundant data block for fault recovery in the event a single disk should fail. Redundant data blocks are always stored on different media servers from the primary block. Should a disk fail, that part of a program which was stored on the failed disk can be retrieved from the redundant data blocks on the remaining servers.

To play a video or audio program, a passenger makes a selection at their passenger set of seat peripherals. This program request initiates a call setup to the media controller **104**. The media controller **104** then schedules the program to be played with the media servers **106** and **108**. A program connection to the passenger's set of seat peripherals consists of three virtual channels: one channel is used for transmission of the data stream; another channel is kept open for the transmission of control signals; and a third channel is kept open for ATM network management signals. The content data is read from the media servers **106** and **108** and sent to the ATM switch **116**. At the ATM switch **116**, the content data arrives on different ports from each media server. The ATM switch **116** then performs a multipoint to point recombination of the content data, thereby creating a single in-sequence data stream which is addressed to the passenger's seat electronics unit.

Content data streams for each seat electronics unit coupled to a zone bridge unit are sent from the ATM switch **116** to the zone bridge unit on a single ATM port, using multiple channels. At the zone bridge unit, the ATM cells for each seat electronics unit are reassembled and segmented into IEEE 1394 packets. The IEEE 1394 packets are then appended with the appropriate destination header and transmitted over the IEEE 1394 network to the appropriate seat electronics unit. At the seat electronics unit, the data is reassembled from the IEEE 1394 packets and sent to the applications within the appropriate passengers set of seat peripherals where the data is extracted from the headers and sent to the MPEG decoder for display.

The video on demand system of the present invention allows a passenger to fast forward and rewind a video program. Note, the term "rewind" is used to relate the present technology to the more familiar video tape technology. If video content is stored on a hard disk, in reality a new start address is selected. However, the form of read and write memory implemented is not critical to the system. These features are supported by only retrieving and displaying MPEG "I" frames which are extracted from the content data using the "I" frame index file, which is also derived from the content data. An MPEG "I" frame is a noncompressed full video frame within the MPEG stream which is used as a reference. When a passenger requests a pause of content, the system will pause all audio and video on demand content playback at the seat electronics unit. After the pause condition is removed, the audio or video content data stream will be resumed.

The audio on demand portion of the system of the present invention also allows a passenger to fast forward and rewind an audio program. Preferably, the in-flight entertainment system allows an airline to provide audio programming from either a jukebox style selection of audio programs, a conventional audio program or station format which plays a particular type of audio programs, or a list of compact disks which can be accessed by the passenger.

The passenger will make selections from menus displayed on the monitor at the seat electronics unit. The passenger is able to point to and select on screen menu options through the use of a cursor control pad on the passenger control unit and a select button. Audio channels are selected from channel selector buttons on the passenger control unit or on screen menus.

OVERHEAD DISPLAY SYSTEM

The overhead display system is driven by the system interface unit **118**. The system interface unit **118** drives each of the overhead monitors or projection system through a smart video display unit. Each smart video display unit preferably supports one or two monitor connections, a video feed through connection to another smart video display unit and an RS-485 multidrop digital control connection. The video content signal is driven baseband differential and is rebuffered in each of the smart video display units.

Each smart video display unit group distributes three independent video channels for a total of six videos per system. Video channels are assigned to a specific aircraft zone. Each smart video display unit is instructed which video channel is selected for each display via the RS-485 interface. The system interface unit **118** has a video multiplexer circuit for each of the three outputs. The multiplexer inputs are two video tape recorder channels, one camera channel, one airshow channel, one spare input and a digital video channel. The audio data corresponding to the overhead video data is broadcast for distribution to the passengers at the seats through the audio distribution system, as described

above. This audio data is broadcast through the second audio path, from the system interface unit **118** through the zone bridge units **138, 140** and **1200** and then to the seat electronics units. The passengers ultimately receive this audio data from the second audio path, through a set of headphones.

The audio distribution system is used for distribution of public address audio, overhead display system audio and entertainment audio. This audio data is distributed to the seats through the second audio path. The system interface unit **118** is responsible for multiplexing the audio sources to the audio outputs. The public address audio inputs are set up for eight different public address zones, whereby audio messages can be selectively sent to predetermined zones within the aircraft.

The in-flight entertainment system of the present invention will pause all video, audio, game and information services during a cabin wide announcement over the public address system. The system will issue public address override signals upon detection of a public address condition. The system interface unit **118** provides indication of the public address override condition to the seat electronics units and to the attendant control panel **110** within the effected zones via the ATM and IEEE 1394 networks, as well as via the second audio path. The seat electronics units will override entertainment audio with public address audio upon receiving a public address override command.

In this manner, as described above, the in-flight entertainment system of the present invention is used to provide flexibility of entertainment options within an aircraft's cabin by combining use of the seat electronics units and the overhead display system on a zone-by-zone basis. The overhead display system is also used as a backup to the seat electronics units. The audio/video on demand features of the in-flight entertainment system are fully interactive, allowing a passenger to stop, pause, fast forward and rewind, as desired. This allows a passenger to leave their seat and return, without missing a portion of their selected entertainment feature. In contrast to other in-flight entertainment systems, the in-flight entertainment system of the present invention also interfaces with other aircraft systems, allowing the crew or flight attendants to fully monitor the status of the aircraft's systems, as well as enter and extract data relating to inventory management and specific usage patterns of the in-flight entertainment system by the passengers.

The present invention has been described in terms of specific embodiments incorporating details to facilitate the understanding of principles of construction and operation of the invention. Such reference herein to specific embodiments and details thereof is not intended to limit the scope of the claims appended hereto. It will be apparent to those skilled in the art that modifications may be made in the embodiment chosen for illustration without departing from the spirit and scope of the invention. For example, while an ATM network and IEEE 1394 serial bus network have been chosen for use in the preferred embodiment, it will be apparent that other types of networks could alternatively be used for communications between the components of the in-flight entertainment system of the present invention. It will also be apparent that the entertainment system of the present invention can also be readily adapted for operation in environments other than aircraft, including but not limited to other transportation modes, e.g. train, bus, ferry and cruise ship.

We claim:

1. An audio distribution system for distributing audio content to one or more passengers on an aircraft comprising:

a. one or more media servers for storing predetermined content data;

b. one or more control sets through which a passenger receives content data;

c. a routing device coupled to the one or more media servers and to a first predetermined number of the control sets, thereby forming a first audio path for routing audio content from the media servers to the first predetermined number of control sets; and

d. a system interface unit coupled to the control sets and for interfacing to existing systems on the aircraft including a PA system, thereby forming a second audio path for routing audio content from the system interface unit to the control sets.

2. The audio distribution system as claimed in claim 1 wherein the system interface unit is also coupled to an overhead display system.

3. The audio distribution system as claimed in claim 2 further comprising one or more zone bridge units, each coupled to the routing device, to the system interface unit and to a second predetermined number of control sets, thereby forming a zone within the aircraft.

4. The audio distribution system as claimed in claim 3 wherein the media servers, the system interface unit and the routing device are coupled together within a first digital network and the zone bridge units and the control sets are coupled together within a second digital network.

5. The audio distribution system as claimed in claim 4 wherein the first digital network is an ATM network and the second digital network is an IEEE 1394 serial bus network.

6. The audio distribution system as claimed in claim 1 further comprising one or more audio content players coupled to the system interface unit for providing audio content to the control sets through the second audio path.

7. The audio distribution system as claimed in claim 1 wherein a PA message overrides all other audio content and is simultaneously transmitted to all control sets through the second audio path.

8. An in-flight entertainment system for providing content to one or more passengers on an aircraft comprising:

a. one or more media servers for storing predetermined content data;

b. one or more control sets through which a passenger receives content data;

c. one or more zone bridge units each coupled to a first predetermined number of control sets thereby forming zones within the aircraft;

d. a routing device coupled to the media servers and to a second predetermined number of the control sets through selected zone bridge units, thereby forming a first audio path for routing audio content from the media servers to the second predetermined number of control sets; and

e. a system interface unit coupled to all of the control sets through the zone bridge units and configured for interfacing to existing systems on the aircraft including a PA system, thereby forming a second audio path for routing audio content from the system interface unit to the control sets.

9. The in-flight entertainment system as claimed in claim 8 wherein each of the second predetermined number of the control sets includes a display, an audio output and an input device for entering controls and playing content data received from the media servers.

10. The in-flight entertainment system as claimed in claim 9 wherein each input device further includes means for making a telephone call.

11. The in-flight entertainment system as claimed in claim 9 wherein the system interface unit is also coupled to an overhead display system.

12. The in-flight entertainment system as claimed in claim 11 wherein the media servers, the system interface unit and the routing device are coupled together within a first digital network and the zone bridge units and the output units are coupled together within a second digital network.

13. The in-flight entertainment system as claimed in claim 12 wherein the first digital network is an ATM network and the second digital network is an IEEE 1394 serial bus network.

14. The in-flight entertainment system as claimed in claim 13 further comprising a media controller coupled to the first digital network for controlling and scheduling communications from the first digital network to the second digital network.

15. The in-flight entertainment system as claimed in claim 14 wherein each control set includes a digital to analog conversion circuit for converting communications received over the second digital network to analog signals, as necessary for appropriately controlling operation of the display and audio output.

16. The in-flight entertainment system as claimed in claim 15 wherein the predetermined content data includes video programs, audio, games and information services.

17. The in-flight entertainment system as claimed in claim 16 wherein each control set further comprises a telecommunications interface for personal telephony functions.

18. The in-flight entertainment system as claimed in claim 17 further comprising a card reader for securing payment by one of a credit card, smart card and debit card from a user for content played and telephone calls made on a control set.

19. A passenger audio distribution system for distributing audio content to one or more passengers on an aircraft, comprising:

a. a first means for storing audio content;

b. a plurality of means for accessing audio content, each for use by passengers for accessing the audio content, the plurality of means for accessing audio content coupled within a first network;

c. first means for routing audio content coupled to the first means for storing audio content within a second network, and to a first predetermined number of the plurality of means for accessing audio content for routing audio content between the first means for storing audio content and the first predetermined number of the plurality of means for accessing audio content, over the first and second networks, thereby forming a first audio path for routing audio content from the first means for storing audio content to the first predetermined number of the plurality of means for accessing audio content; and

d. second means for routing audio content coupled to the plurality of means for accessing audio content and to a means for addressing passengers, thereby forming a second audio path for routing audio content from the second means for routing audio content to the plurality of means for accessing audio content.

20. The passenger audio distribution system as claimed in claim 19 wherein the second means for routing audio content is a system interface unit and is further coupled to an overhead display system.

21. The passenger audio distribution system as claimed in claim 20 further comprising a second means for storing audio content coupled to the system interface unit for providing audio content to the plurality of means for accessing audio content through the second audio path.

22. The passenger audio distribution system as claimed in claim 21 further comprising one or more zone bridge units, each coupled to the first means for routing audio content, to the system interface unit and to a second predetermined number of the plurality of means for accessing audio content, thereby forming a zone within the aircraft.

23. The passenger audio distribution system as claimed in claim 22 wherein the first means for storing audio content, the system interface unit and the first means for routing audio content are coupled together within a first digital network and the zone bridge units and the means for accessing audio content are coupled together within a second digital network.

24. The passenger audio distribution system as claimed in claim 23 wherein the first digital network is an ATM network and the second digital network is an IEEE 1394 serial bus network.

* * * * *

US006384893B1

(12) **United States Patent**
Mercs et al.

(10) **Patent No.: US 6,384,893 B1**
(45) **Date of Patent: May 7, 2002**

(54) **CINEMA NETWORKING SYSTEM**

(75) Inventors: **James Salvatore Mercs**, Huntington Beach; **Ara James Derderian**, Alta Loma, both of CA (US)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Pictures Entertainment, Inc.**, Culver City, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/210,145**

(22) Filed: Dec. 11, 1998

(51) **Int. Cl.**[7] **G03B 19/18**; G03B 21/32; G03B 21/04

(52) **U.S. Cl.** **352/133**; 352/38; 352/40; 352/123

(58) **Field of Search** 352/1, 25, 38, 352/40, 92, 123, 244, 133, 134

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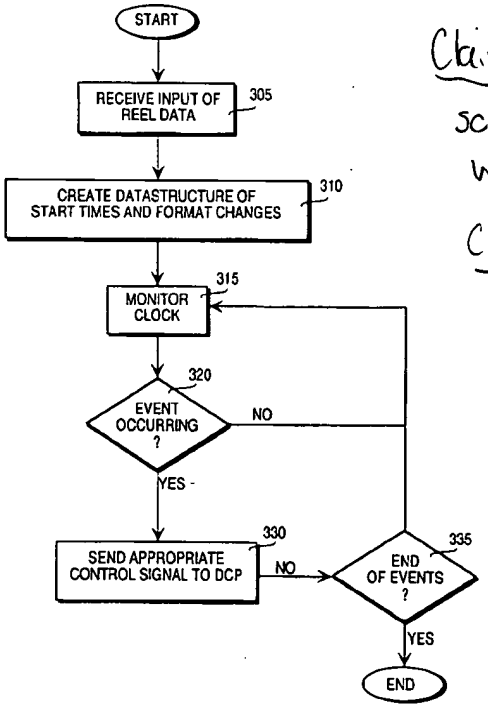
Primary Examiner—Russell Adams
Assistant Examiner—Rodney Fuller
(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman LLP

(57) **ABSTRACT**

A system for automating the control of movie display electronics in a cinema. The system includes a cinema controller which receives as input information regarding start times of movies and the contents of corresponding film reels. The content of the film reel contains a plurality of elements of varying durations and formats. Using the input information, the controller determines the times of play of the different elements and sends the appropriate signals to the appropriate digital cinema processor to perform format changes, sound level changes, etc. in the projection room without operator intervention.

30 Claims, 5 Drawing Sheets



Claim 4
script for controlling action associated w/ content
Claim 5
claim 6, 30

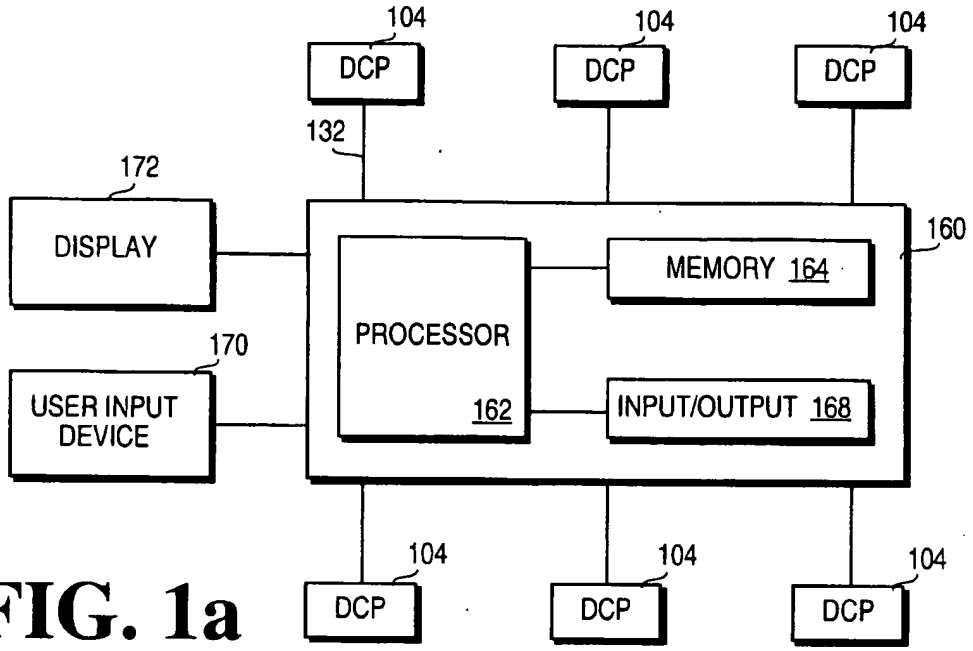

104
DCP
104
DCP
104
DCP
132
172
DISPLAY
160
PROCESSOR
162
MEMORY 164
170
USER INPUT DEVICE
INPUT/OUTPUT 168
104
DCP
104
DCP
104
DCP

FIG. 1a

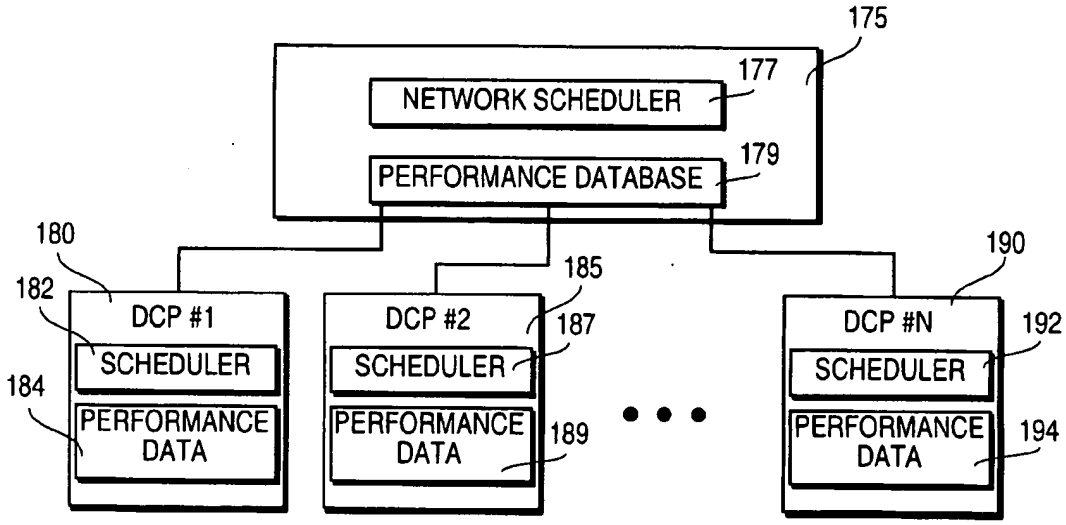

175
177
NETWORK SCHEDULER
179
PERFORMANCE DATABASE
180
182
DCP #1
SCHEDULER
184
PERFORMANCE DATA
185
DCP #2
187
SCHEDULER
PERFORMANCE DATA
189
190
DCP #N
192
SCHEDULER
PERFORMANCE DATA
194

FIG. 1b

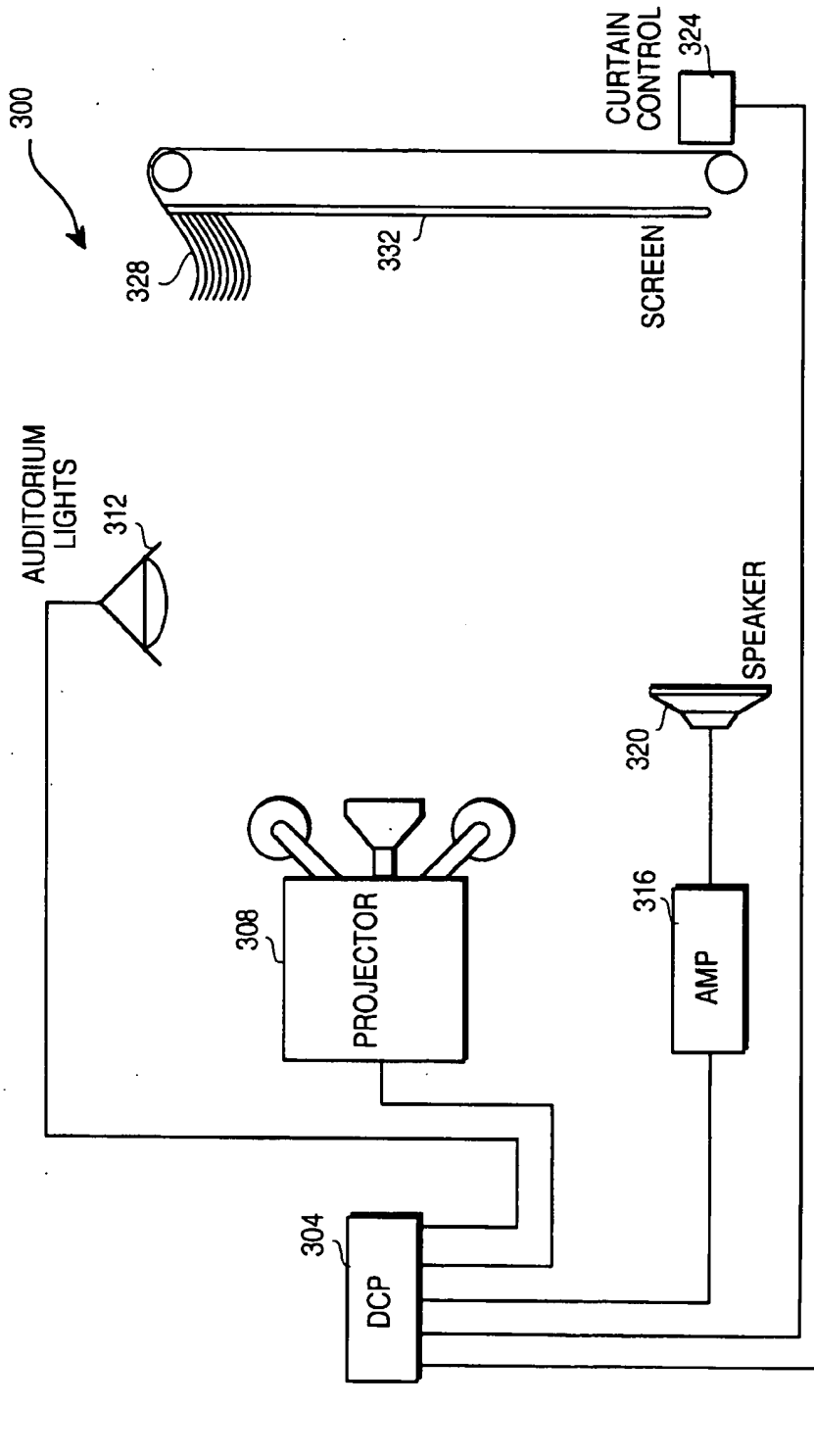


FIG. 2 PROJECTOR / SCREENING ROOM 1

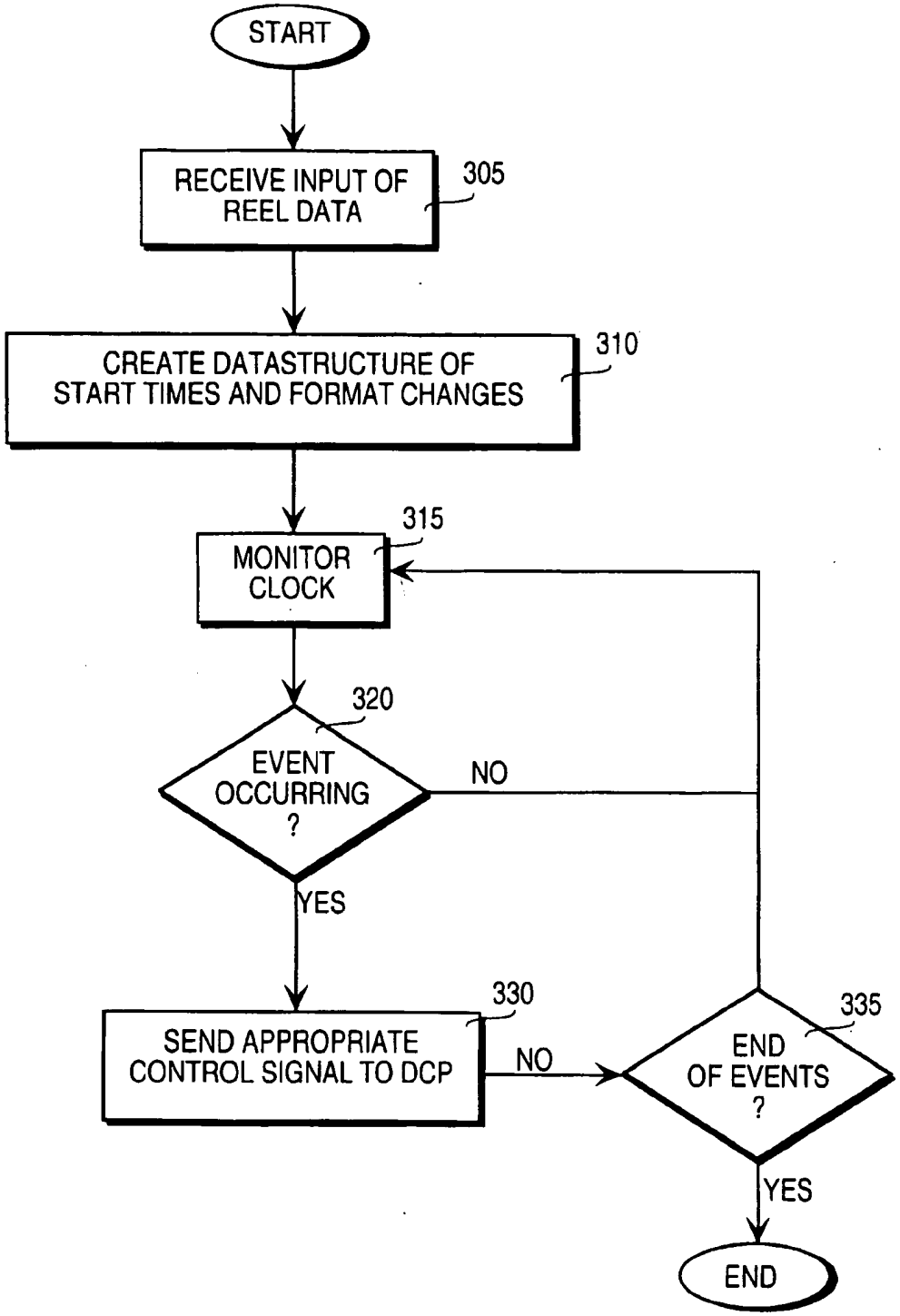

START
RECEIVE INPUT OF REEL DATA
305
CREATE DATASTRUCTURE OF START TIMES AND FORMAT CHANGES
310
MONITOR CLOCK
315
EVENT OCCURRING ?
320
NO
YES
SEND APPROPRIATE CONTROL SIGNAL TO DCP
330
NO
END OF EVENTS ?
335
YES
END

FIG. 3

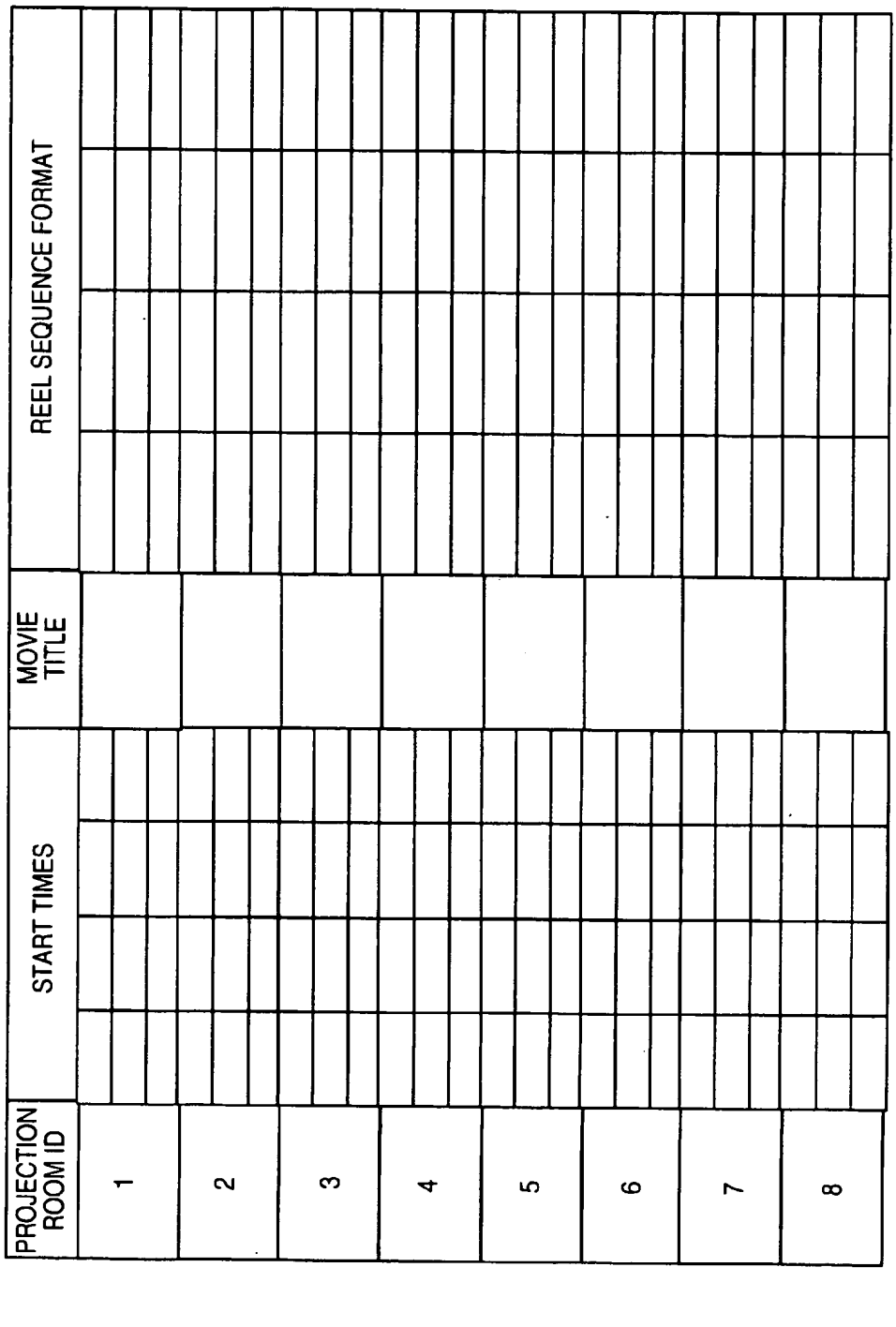

PROJECTION ROOM ID
START TIMES
MOVIE TITLE
REEL SEQUENCE FORMAT
1
2
3
4
5
6
7
8

FIG. 4

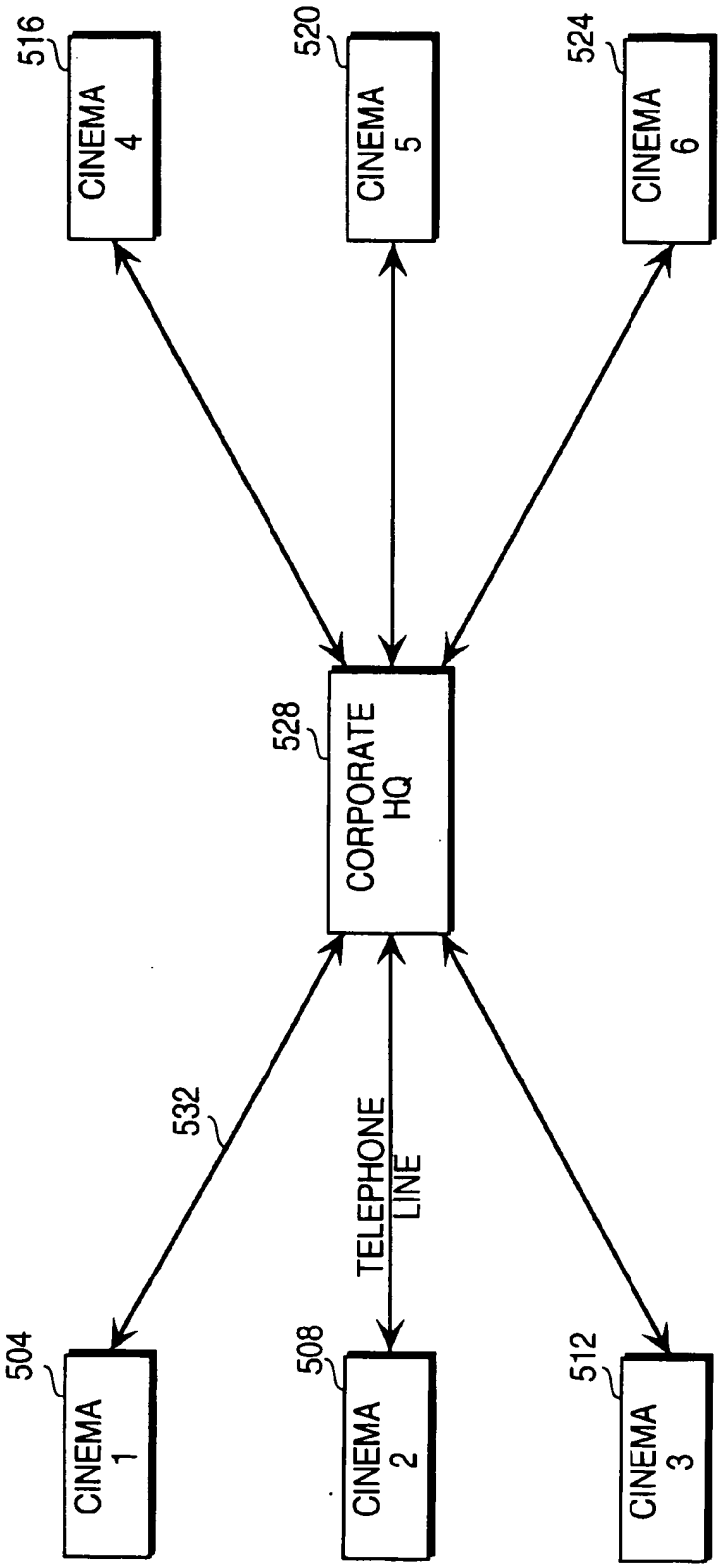

516
CINEMA 4
520
CINEMA 5
524
CINEMA 6
528
CORPORATE HQ
532
TELEPHONE LINE
504
CINEMA 1
508
CINEMA 2
512
CINEMA 3

FIG. 5

CINEMA NETWORKING SYSTEM

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to a control system for a multi-projection room cinema.

(2) Related Art

In recent years, multiplex cinemas have become more popular. Old cinemas typically only had two or three projection rooms, each projection room including at least one projector and a sound system for showing a movie. Typically, a projection operator moves from room to room switching projectors on and off, raising and lowering curtains, dimming lights and controlling sound systems. Most of these tasks were performed at the beginning and end of a movie allowing the projection operator to start and end movies in a first room while a movie was playing in a second room. Modern modem multiplex cinemas have many rooms making it difficult for one projection operator to synchronize movies such that all movies playing in a cinema start and end at different times. Furthermore, it is not uncommon to deliberately schedule movies to start at the same time. Thus several projection operators are required in multiplex cinemas, substantially increasing labor costs.

Furthermore, it is not unusual to have movies in different film formats. Although modern projection devices can typically play different film formats, the actual format needs to be manually selected by an operator. In addition, frequently a film reel will contain a number of segments. For purposes of discussion herein, segments can include the movie, movie trailers and advertising. The number of segments can vary from reel to reel. Each segment can be in a different film format, therefore requiring an adjustment to the projection system each time a format change occurs. Each segment can be of different length, making it difficult to manually predict when to readjust the projection system. Typically, cinema operators watch for mechanical queues, such as a small flash of light which appears on the upper corner of the screen, and manually change the settings on the projection system when the operator sees the mechanical queue. In large multiplex cinemas, this process requires a large number of operators to monitor and operate the projection equipment as many movies are ongoing at the same time and each may have a different number of segments and sequence of play of segments.

In addition, in a multiplex cinema equipment failures can easily go undetected. Typically, the failures are noticed only by periodic checks by cinema operators or by complaining patrons. Thus, a significant amount of time can pass before the projection operator is aware of the equipment failure.

SUMMARY

The system and method of the present invention enables the remote monitoring and control of one or more projection rooms in a cinema. In one embodiment, a cinema controller is coupled to a number of cinema processors to manage the electronics in each projection room of a cinema. Information regarding the movies, start times and film reel content is input to the cinema controller. Using this information, the cinema controller issues the proper control signals to a specific cinema processor in order to play a particular film reel component in its specified format. Using this system, the need for cinema operators to closely monitor and perform manual format adjustments is avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a block diagram illustrating one embodiment of a network of digital cinema processors (DCP) and a cinema controller in accordance with the teachings of the present invention and FIG. 1*b* is a functional block diagram illustrating one embodiment of a network of DCPs and a cinema controller.

FIG. 2 illustrates an exemplary cinema projection room.

FIG. 3 is a flow chart illustrating one embodiment of the process performed by the cinema controller in accordance with the teachings of the present invention.

FIG. 4 is a table illustrating an exemplary input in accordance with the teachings of the present invention.

FIG. 5 is a block diagram illustrating one embodiment of a corporate network of cinema controllers in accordance with the teachings of the present invention.

DETAILED DESCRIPTION

In the following discussion, a control system for controlling electronic equipment in a cinema will be described. In one embodiment a network in a multiplex cinema includes a central cinema controller that communicates with one or more digital control processors (DCPs). Each DCP monitors and controls the electronics in one or more projection rooms of the cinema, minimizing the number of operators needed to run the cinema.

In another embodiment, the system of the present invention coordinates one or more cinemas with a central site such as a headquarters office. Thus, a server computer at the central site communicates with a network of one or more cinema controllers, each cinema controller coordinating one or more DCPs, each DCP monitoring and controlling electronics in at least one projection room of the cinema.

In the described embodiment, a number of details will be included to facilitate understanding of the invention. For example, although embodiments described herein utilized DCPs, the present invention is not limited to DCPs and can include a variety of types of cinema processors that include digital circuitry to process digital formatted film, digital circuitry to process analog formatted film and analog circuitry to process analog formatted film. In addition, the cinema processors may include the logic and circuits needed to communicate with the controller and selectively perform other functions described below. Cinema processors may also be configured to control projection room equipment which may include projection apparatus as described herein as well as other types of video equipment, audio equipment, for example, sound systems, lighting, climate control and curtains. Furthermore, multiple cinema processors may be employed to control various equipment used to operate functions of a projection room.

Furthermore, the connection between the cinema controller and each DCP will be described as a RS-232 serial connection and the communication medium between the cinema controller and the server computer will be described as a telephone line. However, it is recognized that modifications of such details could be implemented by one of ordinary skill in the art and still fall within the scope of the invention. The details provided in this description are intended to facilitate understanding of the invention and describe a preferred embodiment of the invention and should not be used to limit the scope of the invention. The scope of the invention should only be defined in terms of the claims at the end of this patent.

FIG. 1*a* illustrates a schematic block diagram of one embodiment of a cinema controller **160** coupled to a plurality of digital cinema processors (DCPs) **104**. In one embodiment, the DCP is a Sony Digital Cinema Processor 1000, manufactured by Sony Corporation of Japan.

The cinema controller **160** includes a processor **162**, memory **164**, input/output circuitry **168**, a user control device such as a mouse or a keyboard and a display **172**. In one embodiment the controller **160** is a personal computer such as an Intel® processor-based machine (Intel is a trademark of Intel Corporation). In this embodiment, instructions are stored on a medium, such as memory **164** and executed by the processor **162** to perform the tasks described herein. Input to the controller **160** can be achieved a variety of ways including via a keyboard or on-screen input menu. Furthermore, it is contemplated that the input may be received over a communications link, such as a telephone or data line, from an external site, including a main office computer system.

Control data and status information may be communicated between a DCP **104** and the controller **160**. For example, the DCP **104** may periodically transfer data, or transfer on the occurrence of predetermined events. Alternately, the cinema controller **160** requests data. Preferably, the cinema controller **160** requests status information in a background mode allowing the DCP **104** to perform other tasks during the information transfer process. Background transmission of data results in minimal system degradation.

Communication between the DCP and the cinema controller **160** may be implemented a variety of ways. In one embodiment, communication is implemented using a serial port transmitting and receiving signals over a local communications link such as communications link **132** coupling DCP **104** to the cinema controller **160**. In one embodiment, the local communications link **132** is an RS-232 serial cable and is connected to the COMM port 2 of the Sony DCP 1000. It is readily apparent that a variety of communication media and protocols can be used including wireless and optical communication media. In one embodiment, the communication between cinema controller **160** and the DCP **104** occurs at an asynchronous transfer rate of about 9,600 baud. Each byte of information transmitted or received across the local communications link **132** has a start bit prefacing the byte. A stop bit is also appended to each byte. No parity bit is used. The DCP **104** monitors the serial port for automation data allowing the cinema controller **160** to initiate communication by merely transmitting messages.

Flow control may be accomplished a variety of ways including by using acknowledgment (ACK) and negative acknowledgment (NACK) messages. Each DCP can be programmed to have a unique identification (ID). To assure proper communications, the cinema controller **160** may transmit a detection message and wait for the DCP **104** to respond with an ACK message before new commands or detection messages are sent. An ACK message from the DCP **104** may indicate that either the last command was completed successfully or that the last message was received and processed successfully. When a negative acknowledgment (NACK) message is received, the cinema controller **160** may respond by retransmitting the command or detection message. A NACK message transmitted by the, DCP **104** indicates that the corresponding command or message received from the cinema controller **160** is not valid. The cinema controller **160** may respond by retransmitting the last command. Alternatively, the cinema controller **160** may transmit an alternate command. Besides indicating that a command was not valid or not properly received, a NACK code may also include further information. For example, NACK codes may be encoded to indicate a check sum error, an undefined control byte error, an undefined request, a volume or gain out of range problem, or an incomplete message.

In one embodiment of the invention, software running within the cinema controller **160** controls the transmission of the requests and the handling of ACK and NACK responses received from the DCP **104**. A clock in the cinema controller **160** coordinates the transmission of requests and the receipt of appropriate response signals including the NACK and ACK signals. Preferably, DCP clocks in each DCP **104** are preferably synchronized to a cinema controller clock (not shown) allowing each DCP **104** to implement command functions from the controller **160** including when to start projectors, dim auditorium lights and open and close curtains.

The DCP **104** may also be configured to accumulate and determine statistics including data on the number of hours of operation since the last inquiry from the cinema controller **160**, a record of start and stop times, a record of problems or equipment failures, and the DCP hardware configuration used. This information can then be transmitted to the controller **160** for operation and maintenance tracking and reporting. In one embodiment, the controller **160** stores data from the DCP **104** in a file. This data may subsequently be received by an operator, for example, through a spreadsheet program.

When a problem is detected, the DCP **104** communicates the problem to the main cinema controller **160** using an interrupt. Thus emergency problems may be addressed immediately. In addition, it is preferred that when such an interrupt occurs, a display message may be transmitted to a monitoring or display device on the main cinema controller **160** indicating that a particular projection room corresponding to the DCP **104** needs immediate servicing or attention. The cinema controller **160** may also be programmed to handle problems or suggest appropriate corrective steps.

The cinema controller **160** uses the cinema controller clock to maintain time records of events that occur in each room. For example, if records indicate that equipment in a projection room is failing more often than equipment in other projection rooms, a more thorough service or maintenance may be performed. In one embodiment, the cinema controller **160** may also record information such as ticket sales corresponding to each movie performance in each room of the cinema.

FIG. **1***b* is a functional block diagram of one embodiment of a system that operates in accordance with the teachings of the present invention. The controller **175** is connected to one or more DCPs **180, 185, 190**. The controller includes a network scheduler process **177** and a performance database **179**. The network scheduler process **177** includes logic to receive input regarding scheduling including movie schedules, film formats and other cinema operations which may be stored at the controller **175**. The controller **175** uses the input to issues appropriate commands at the appropriate times to control the operation of the DCPs **180, 185, 190**. DCPs **180, 185, 190** include scheduling logic **182, 187, 192** that receives the scheduling commands from controller **175** and performs the operations indicated by the command, including starting play of a film, setting format changes and modifying sound levels.

The controller **175** also includes a performance database **179** that stores information regarding the performance of the cinema. For example, the database may include data such as actual start times, films played as well as maintenance records. Other information may also be included. In one embodiment, the controller **175** is part of or coupled to a ticket system that is used in the operation of ticket sales. In this embodiment, the performance database **179** includes

sales information. Alternately, sales information may be input by an operator into the performance database **179** of the controller **175**.

Typically, the performance data relevant to each DCP **180**, **185**, **190** is generated by performance data logic **184**, **189**, **194**. Transmission of performance data may be trigger by a clock or upon occurrence of predetermined events. Such transmissions may be performed in the background of the controller **175** and DCPs **180**, **185**, **190**.

FIG. **2** illustrates a DCP **204** operating in a projection room **200** of a cinema. The DCP **204** controls the operation of the coupled projector **208**. For example, the DCP **204** controls the start and completion of the projection of the contents of a film reel by projector **208**. Furthermore, the DCP **204** may also adjust operating modes of projector **208** to account for different movie formats. Such movie formats may include adjusting aspect ratios and soundtrack information. Examples of formats include those compatible with Dolby SR, Dolby A Noise Reduction and WR1, WR2 Digital Analog Passthrough.

In other embodiments of the invention, additional control signals generated by the DCP **204** in response to control signals issued by the controller, control the auditorium lights **212**, turning on the lights after the movie, and dimming them or switching them off during the movie. The DCP **204** may be programmed to partially dim the auditorium lights **212** during the movie previews allowing late audience customers to come into a cinema room **204** with some lighting. In one embodiment of the invention, DCP **204** may also be coupled to a sound system including an amplifier **216** which amplifies the movie soundtrack output to a speaker **220**. The DCP **204** may adjust amplifier **216** gain to accommodate particular acoustics of the room **200** and the type of movie being shown. In one embodiment, the DCP **204** controls a curtain control **224** which raises and lowers a curtain **228** over a screen **232**. The DCP **204** may transmit signals causing the curtain control **224** to automatically raise the curtain **228** before the movie and automatically lower the curtain **228** at the end of the movie.

Alternately, at least one separate device coupled to the controller may be used to control the projection room environment, including sound, lighting, temperature in the room, etc. Such a device would receive appropriate signals from the controller and perform the appropriate tasks.

One embodiment of a process for controlling one or more projection rooms is illustrated by the flow chart of FIG. **3**. At step **305**, the input information is received. In the present embodiment, this information includes an identification of the projection room, and therefore, in the present embodiment, the DCP, (in a multiplex environment composed of multiple projection rooms), the title of the movie to be played in each projection room, the start time(s) of the movie(s) to be played in each projection room, and the sequence, format and duration of the segments on the film reel to be played. Other information may also be input, such as how to adjust the sound system, when to dim the lights, raise/lower the curtain, etc.

The information can be input a variety of ways. In one embodiment, the information is manually entered into a file or database for subsequent reference. An example of an entry form that may be displayed is illustrated in FIG. **4**. In this embodiment, an operator enters, either via a keyboard and/or by using a cursor control device, a description of the content of the film reels including the duration and film format of each segment. In addition, a film identifier, such as the title, is supplied along with the times it is to be played in a particular projection room. Other embodiments are also contemplated. For example, the information may be received or downloaded from a remote centralized location. Alternately, the information may be retrievable from a web site maintained to contain such information.

Referring back to FIG. **3**, at step **310** a data structure is generated using the input received. This data structure may be embodied a variety of ways including in a database, spreadsheet, a text file or even a data stream of coded information representative of the input. Preferably, the data structure includes times of each event, e.g., format changes calculated from the scheduled start time of the film reel and the sequence and duration of the film reel elements.

The system references the data structure to determine when to send particular control signals to the appropriate DCPs to perform automatic format changes without operator intervention. In an alternate embodiment, the system references the data structure to perform other control functions including the lights, curtains and level of sound in the particular projection room.

At step **315**, the controller monitors a clock and if at step **320**, an event is to occur, then the controller generates the appropriate command to send to the DCP, step **330**. The clock can be an external clock or one internally generated. In one embodiment, all the DCPs in a cinema are controlled by the same controller; therefore, the start times, etc., are synchronized. In an alternate embodiment configured by multiple controllers, the controllers are synchronized by an external clock or a clock of one of the controllers. The commands to be sent may be coded into the software or alternately stored in a data structure for easy retrieval and update as necessary to accommodate subsequent upgrades to the DCPs or the controller.

If no further events are to be performed, step **335**, the process is complete; otherwise, the controller continues to monitor the clock, and perform steps **315**, **320**, **330** as necessary.

Using this process, the need to have an operator constantly monitor a projection room is avoided as all format changes on a reel and other projection room operations are automatically controlled.

In an alternate embodiment, the controller monitors the DCPs to determine when maintenance or operator intervention is required. Thus, if something goes wrong in the projection room, the controller will alert an operator to address the problem. In this embodiment, the controller polls the DCPs or monitors interrupt signals received from the DCPs which may be indicative of problems. Some maintenance may be automatic. For example, if an error occurs during play of digital tracks of a film, a switch may be made to use the analog tracks.

Sensors around the cinema room may provide additional information on whether all of the electronics in a projection room are working properly. Sensors used may include microphones to detect whether the sound system is outputting the proper volume of sound and photo-detectors to monitor the ambient light conditions. After receiving the status query, the DCP acknowledges the status query and transmits the operational status of the projection room. This information may be used to generate maintenance records which may be used to determine when maintenance or equipment replacement is needed.

The controller can also be configured to maintain operation records of the different projection rooms. For example the controller may maintain records of how many times a particular movie was played. Furthermore, it is contem-

plated that the operation records may include information input regarding attendance and revenue.

In an alternate embodiment, a plurality of cinema controllers located at the same cinema complex or different complexes communicate with a central office. This is illustrated in FIG. **5**.

FIG. **5** is a block diagram showing one embodiment of a layout of network of cinema controllers **504, 508, 512, 516, 520, 524** coupled to a server computer **528**. Each cinema controller **504, 508, 512, 516, 520, 524** is coupled to the server computer **528** via a communications link **532**. The communications link may be a telephone line, an ISDN connection or a variety of cable or wireless transfer mechanisms. It is contemplated that a variety of network configurations may be used. For example, local groups of cinema controllers may be clustered together or connected to a local server (which may be one of the cinema controllers) which is also connected to the server computer **528**. Furthermore, it is contemplated that server computer **528** may be one or more networked computers performing the functionality described herein.

Each cinema controller **504 508, 512, 516, 520, 524** communicates data collected at a cinema over a corresponding communication link such as communications link **532**. A variety with data related to the business and conditions may be collected. The data may include status information such as the intended and actual start times and end times of movies playing, the titles of movies that are playing, ticket sales for each schedule of each movie, equipment failures at the cinema, and types of equipment used at the cinema. In one embodiment, each cinema controller **504, 508, 512, 516, 520, 524** aggregates the data recovered from the DCPs and automatically transmits the data to the network server computer **528**. Alternately, the server computer calls each cinema controller **504, 508, 512, 516, 520, 524** and requests data. Such data requests preferably occurs after hours when telephone rates and telephone traffic is minimized. In such a polling model, the server computer **528** may request specific status information as needed.

While certain exemplary embodiments have been described in detail and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention is not to be limited to the specific arrangements and constructions shown and described, since various other modifications may occur to those with ordinary skill in the art.

What is claimed:

1. A cinema system comprising:

a plurality of projection apparatuses configured to display the contents of film reels on a plurality of screens;

a plurality of cinema processors, each cinema processor coupled to one projection apparatus of the plurality of projection apparatuses, each cinema processor configured to control the operation of the one coupled projection apparatus; and

a cinema controller coupled to each cinema processor of the plurality of cinema processors and configured to control each cinema processor, said cinema controller comprising a data structure comprising start times of film reels, contents of film reels containing a plurality of film reel elements, and a sequence, format and duration of each film element, said cinema controller further configured to control each cinema processor in accordance with a clock and the data structure such that manual intervention to start film reels and change projection format on the one coupled projection apparatus is eliminated.

2. The cinema system as set forth in claim **1**, wherein film reel elements are selected from the group consisting of movies, movie trailers and advertisements.

3. The cinema system as set forth in claim **1**, said cinema controller further comprising an input device configured to receive at least some of the contents of the data structure and store the contents in the data structure.

4. The cinema system as set forth in claim **3**, wherein the input device is a keyboard.

5. The cinema system as set forth in claim **3**, wherein the input device is a data port configured to receive a data stream.

6. The cinema system as set forth in claim **3**, wherein the input device is a data port configured to access a central location containing the contents of the data structure.

7. The cinema system as set forth in claim **1**, said cinema processor is further configured to communicate device status information to the cinema controller, said cinema controller further configured to monitor device status information and provide alerts when a projection apparatus of said plurality of projection apparatuses or cinema processor of said plurality of cinema processors requires maintenance.

8. The cinema system as set forth in claim **1**, further comprising a central office server, said server configured to receive operational information from the cinema controller.

9. A method for controlling the operation of a cinema comprising:

providing a cinema controller coupled to a plurality of projection rooms, each projection room consisting of a projection apparatus;

monitoring a clock;

accessing a data structure comprising start times of film reels, contents of film reels containing a plurality of film reel elements, and a sequence, format and duration of each film reel element;

determining when an event occurs which requires an action in one projection room, said event determined based upon the clock and the data structure; and

issuing a control signal to the one projection room to perform the action in accordance with the clock and the data structure such that manual intervention to start film reels and change projection format on the projection apparatus is eliminated.

10. The method as set forth in claim **9**, wherein the step of determining comprises the steps of:

referencing the start time of a film reel; and

determining a time for each format change based on the start time,

sequence of elements and duration of each element.

11. The method as set forth in claim **9**, further comprising the step of receiving contents of the data structure through an input device.

12. The method as set forth in claim **11**, wherein the step of receiving comprises the steps of accessing a central location and retrieving at least some of the contents of the data structure.

13. The method as set forth in claim **11**, wherein the step of receiving comprises the step of an operator entering at least some of the contents of the data structure using the input device.

14. The method as set forth in claim **9**, further comprising the steps of: receiving maintenance information from the one projection room; and alerting an operator that maintenance is needed.

15. The method as set forth in claim 9, further comprising the steps of:

maintaining operation information; and

communicating operation information to a central office server.

16. A computer readable medium containing instructions, which when executed in a processing system, cause the system to perform a method for controlling the operation of a cinema, the cinema comprising a plurality of projection rooms, each projection room including projection room equipment, the method comprising:

monitoring a clock;

accessing a data structure comprising start times of film reels, contents of film reels containing a plurality of film reel elements, and a sequence, format and duration of each film reel element;

determining when an event occurs which requires an action in one projection room, said event determined based upon the clock and the data structure; and

issuing a control signal to the one projection room to perform the action in accordance with the clock and the data structure such that manual intervention to start film reels and change projection format on the projection room equipment is eliminated.

17. The computer readable medium as set forth in claim 16, wherein instructions, which when executed determine when an event occurs, comprise:

referencing the start time of a film reel; and

determining a time for each format change based on the start time,

sequence of elements and duration of each element.

18. The computer readable medium as set forth in claim 16, further comprising instructions, which when executed, perform a step of receiving contents of the data structure through an input device.

19. The computer readable medium as set forth in claim 18, wherein instructions, when executed, receive contents of the data structure, access a central location and retrieve at least some of the contents of the data structure using the input device.

20. The computer readable medium as set forth in claim 18, wherein instructions, when executed, receive contents of the data structure, include an operator entering at least some of the contents of the data structure using the input device.

21. The computer readable medium as set forth in claim 16, further comprising instructions, which when executed in a processing system, perform maintenance alerts comprising the steps of:

receiving maintenance information from the one projection room; and alerting an operator that maintenance is needed.

22. A cinema system comprising:

a plurality of cinema processors, each cinema-processor coupled to projection room equipment, each cinema processor configured to control the coupled projection room equipment; and

a cinema controller coupled to each cinema processor of the plurality of cinema processors and configured to control each cinema processor, said cinema controller comprising a data structure comprising start times of cinema operations relative to the projection room equipment, said cinema controller further configured to control each cinema processor in accordance with a clock and the data structure such that manual intervention to control the coupled projection room equipment is eliminated.

23. The cinema system as set forth in claim 22, wherein the projection room equipment is selected from a group comprising projection apparatus, video equipment, audio equipment, climate control, lighting and curtains.

24. The cinema system as set forth in claim 22, said cinema controller further comprising an input device configured to receive at least some of the contents of the data structure and store the contents of the data structure.

25. The cinema system as set forth in claim 22, said each cinema processor configured to communicate equipment status information to the cinema controller, said cinema controller further configured to monitor equipment status information and provide alerts when equipment requires maintenance.

26. The cinema system as set forth in claim 22, further comprising a central office server, said server configured to receive operational information from the cinema controller.

27. A method for controlling the operation of a cinema comprising:

providing a cinema controller coupled to a plurality of projection rooms, each projection room comprising projection room equipment;

monitoring a clock;

accessing a data structure comprising start times of cinema operations relative to the projection room equipment, contents of film reels containing a plurality of film reel elements, and a sequence, format and duration of each film reel element;

determining when an event occurs which requires an action in one projection room, said event determined based upon the clock and the data structure; and

issuing a control signal to the one projection room to perform the action in accordance with the clock and the data structure such that manual intervention to start film reels and change projection format on the projection room equipment is eliminated.

28. The method as set forth in claim 27, further comprising:

receiving information from the one projection room; and alerting an operator that maintenance is needed.

29. A computer readable medium containing instructions, which when executed in a processing system, cause the system to perform a method for controlling the operation of a cinema, the cinema comprising a plurality of projection rooms, each projection room including projection room equipment, the method comprising:

monitoring a clock;

accessing a data structure comprising start times of cinema operations relative to projection room equipment, contents of film reels containing a plurality of film reel elements, and a sequence, format and duration of each film reel element; and

determining when an event occurs which requires an action in one projection room, said event determined based upon the clock and the data structure;

issuing a control signal to the one projection room to perform the action in accordance with the clock and the data structure such that manual intervention to start film reels and change projection format on the projection room equipment is eliminated.

30. The computer readable medium as set forth in claim 29, further comprising instructions, which when executed, provide information regarding maintenance, comprising:

receiving information from the one projection room; and alerting an operator that maintenance is needed.

* * * * *

US005801754A

United States Patent [19]

Ruybal et al.

[11] Patent Number: 5,801,754

[45] Date of Patent: Sep. 1, 1998

[54] **INTERACTIVE THEATER NETWORK SYSTEM**

[75] Inventors: **Edward James Ruybal**, Arapahoe; **Timothy Leo Rust**, Highlands Ranch; **Michael David Aisner**, Boulder, all of Colo.

[73] Assignee: **United Artists Theatre Circuit, Inc.**, Englewood, Colo.

[21] Appl. No.: **559,566**

[22] Filed: **Nov. 16, 1995**

[51] **Int. Cl.**[6] **H04N 7/14**

[52] **U.S. Cl.** **348/13**; 348/7; 348/16

[58] **Field of Search** 348/13, 7, 12, 348/722, 705, 470, 1, 16; 379/92.01, 92.03, 92.04

[56] **References Cited**

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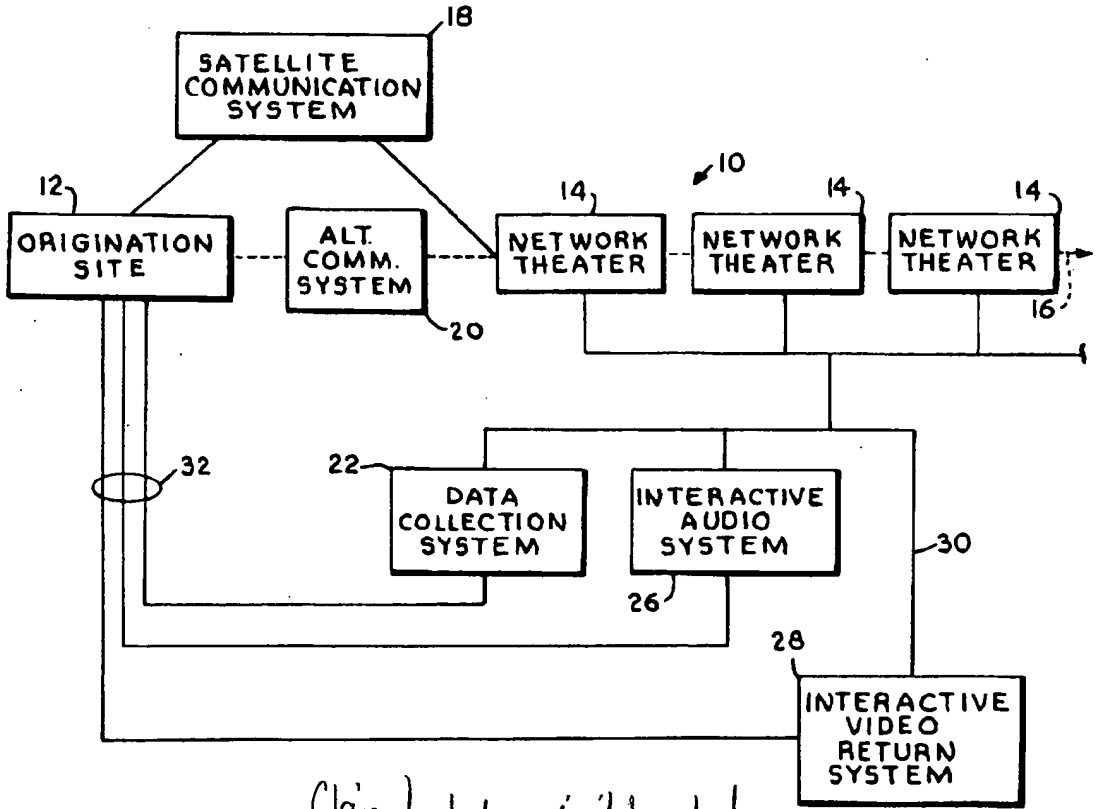
Primary Examiner—Victor R. Kostak

Attorney, Agent, or Firm—Shook, Hardy & Bacon L.L.P.

[57] **ABSTRACT**

An interactive theater network system links a plurality of motion picture theater auditoriums so that live, interactive events can be conducted with theater audiences throughout the theater network. An origination site broadcasts information relating to the interactive event, and a plurality of network theater auditoriums are interactively linked with the origination site. Each network theater includes a full-motion picture projection system configured to receive the interactive event information from the origination site and present the information to the theater audiences. The interactive event information is transmitted from the origination site to the plurality of network theaters with a broadcast communication system. An audience response system provides interactive communication between the origination site and audience members from the network theaters. As part of the audience response system, a data collection system collects and processes data relating to the interactive event that is generated from the audience members. An interactive communication system also provides audio and video communications during the interactive event between audience members across the network and the origination site.

31 Claims, 3 Drawing Sheets



Claim 1, but no digital content

Claim 2

Suggestion for claim 9 & 10

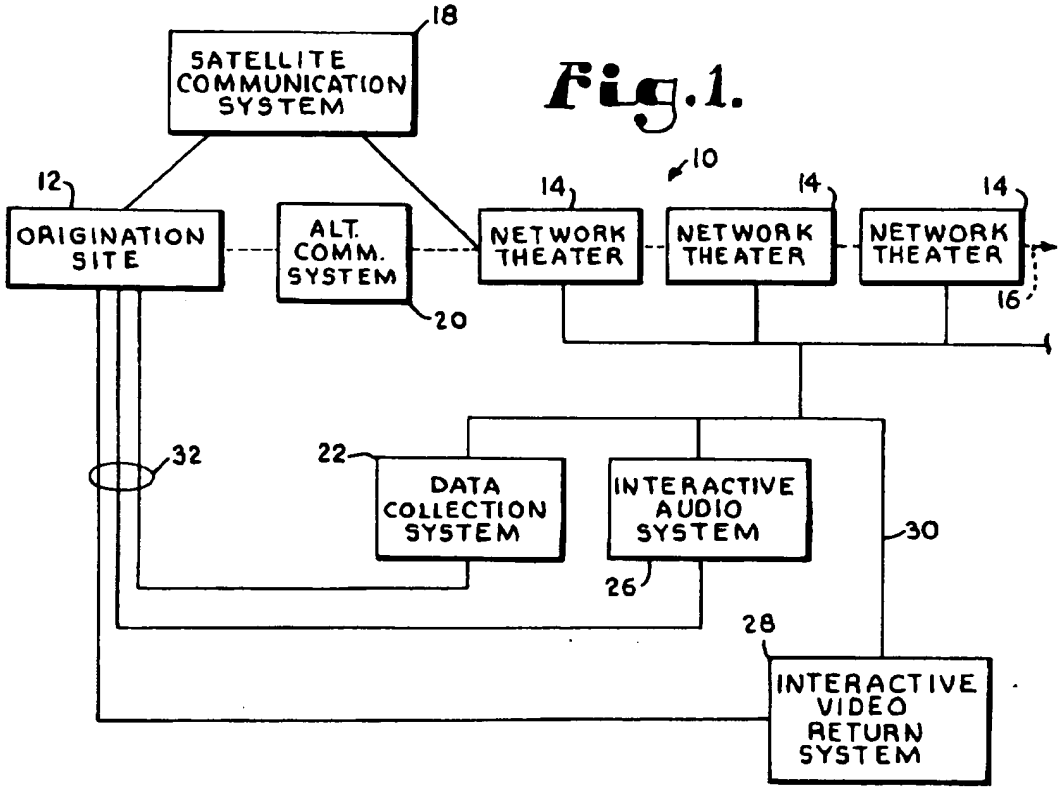

18
SATELLITE COMMUNICATION SYSTEM
12
ORIGINATION SITE
ALT. COMM. SYSTEM
20
10
14
NETWORK THEATER
14
NETWORK THEATER
14
NETWORK THEATER
16
32
22
DATA COLLECTION SYSTEM
INTERACTIVE AUDIO SYSTEM
26
30
28
INTERACTIVE VIDEO RETURN SYSTEM

Fig.1.

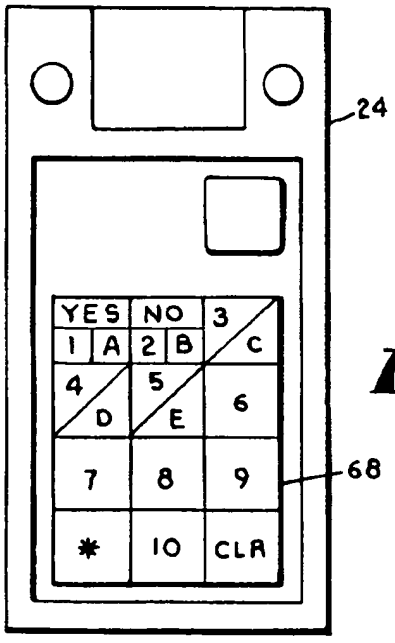

24
YES
NO
3
1
A
2
B
C
4
D
5
E
6
7
8
9
68
*
10
CLR

Fig.3.

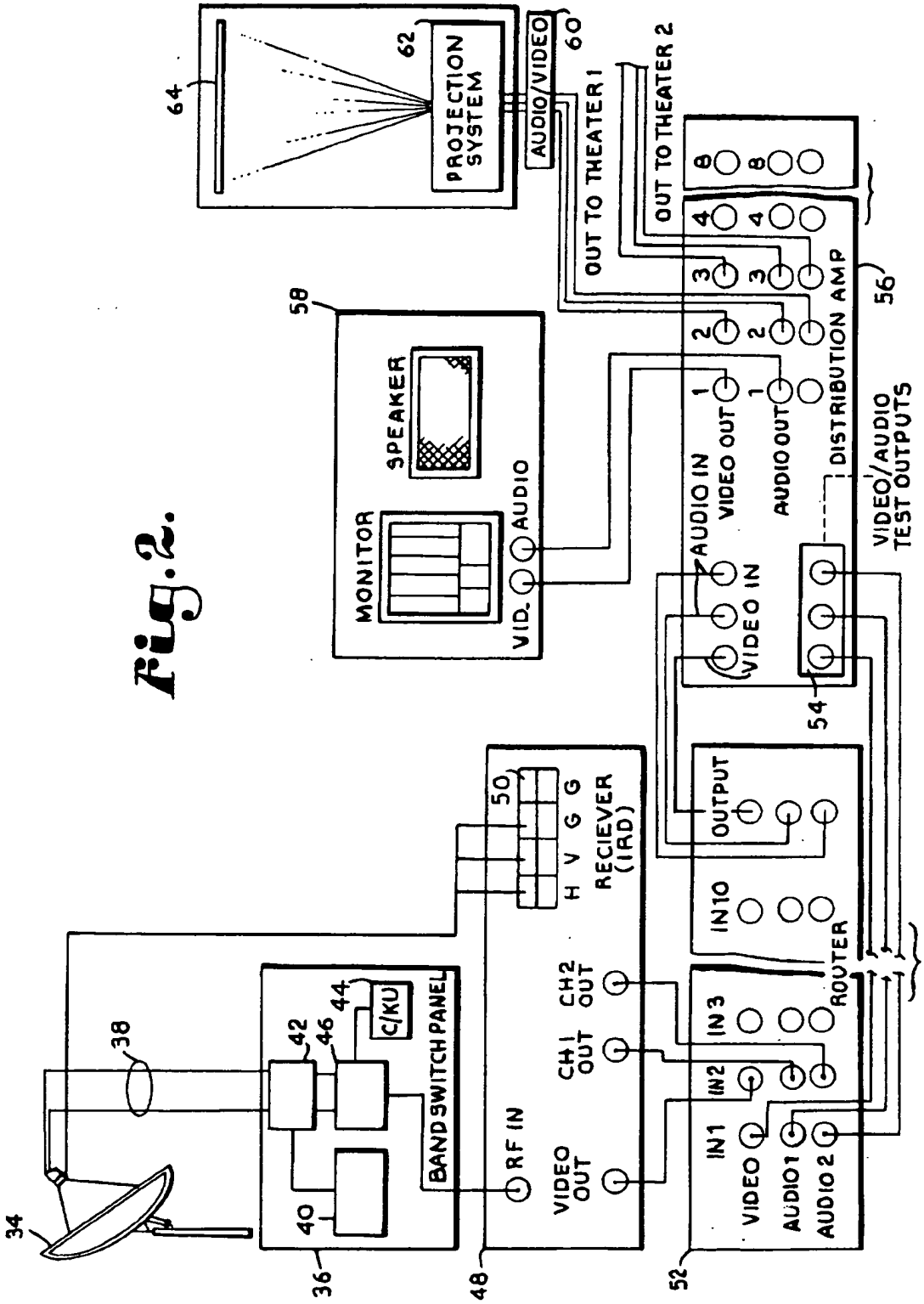
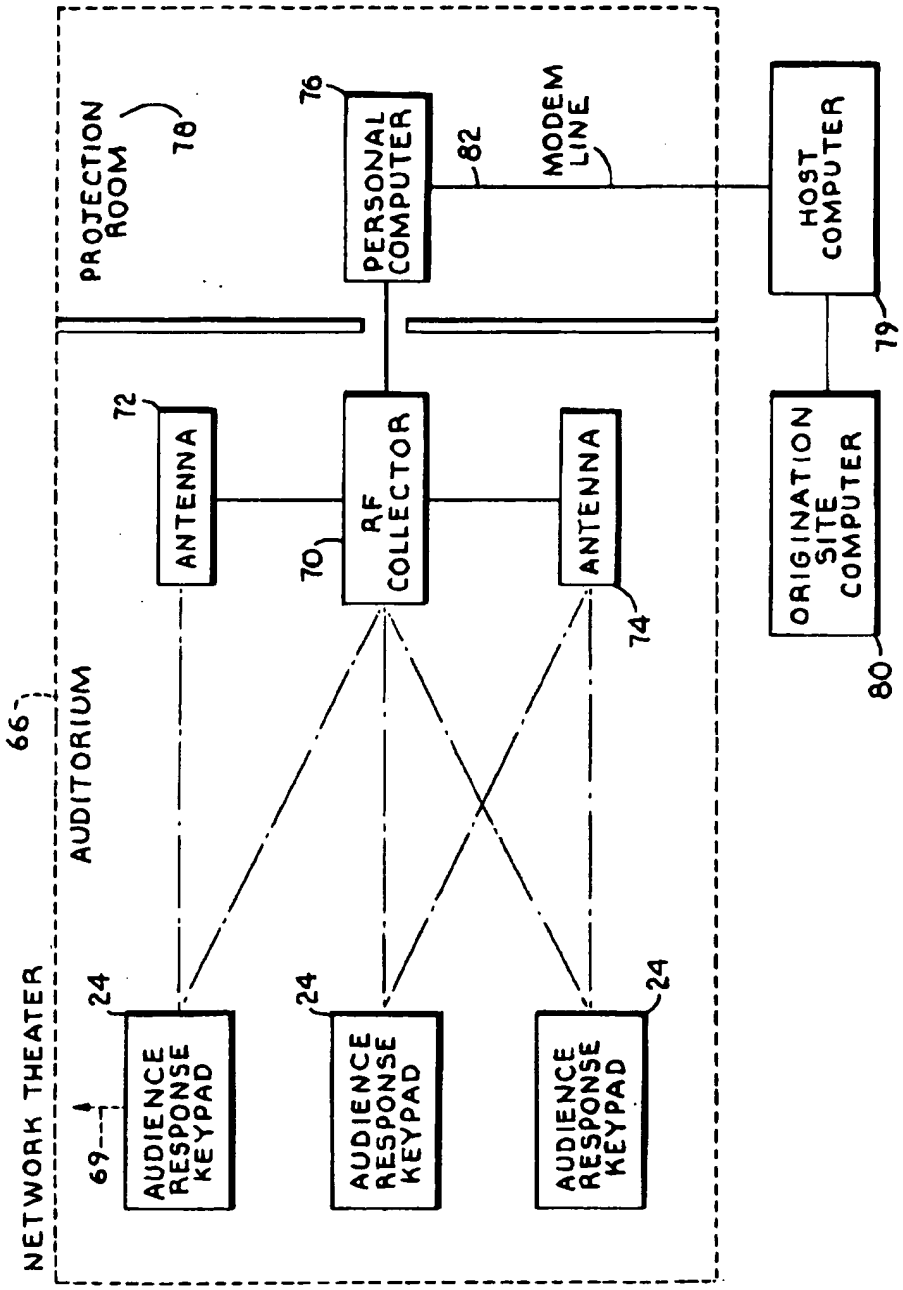

64
62
PROJECTION SYSTEM
AUDIO/VIDEO
60
OUT TO THEATER 1
OUT TO THEATER 2
58
SPEAKER
MONITOR
AUDIO
VID.
AUDIO IN
VIDEO OUT
AUDIO OUT
DISTRIBUTION AMP
56
VIDEO/AUDIO TEST OUTPUTS
VIDEO IN
54
OUTPUT
IN10
ROUTER
IN 3
IN2
IN1
VIDEO
AUDIO 1
AUDIO 2
52
50
H V G G
RECIEVER (IRD)
CH2 OUT
CH1 OUT
VIDEO OUT
RF IN
48
38
42
46
44
C/KU
BAND SWITCH PANEL
40
36
34

Fig. 2.

Fig.4.


NETWORK THEATER
AUDITORIUM
66
PROJECTION ROOM
78
76
PERSONAL COMPUTER
82
MODEM LINE
HOST COMPUTER
79
72
ANTENNA
RF COLLECTOR
70
ANTENNA
74
ORIGINATION SITE COMPUTER
80
24
AUDIENCE RESPONSE KEYPAD
69
24
AUDIENCE RESPONSE KEYPAD
24
AUDIENCE RESPONSE KEYPAD

INTERACTIVE THEATER NETWORK SYSTEM

FIELD OF THE INVENTION

This invention relates to interactive communications and, more particularly, to a system for interactively linking a plurality of motion picture theaters to conduct live, interactive events.

BACKGROUND OF THE INVENTION

In recent years, there has been significant growth in the area of special event presentations such as seminars, multimedia business presentations, training, distance learning, business conferences, polling, etc. Because of the popularity and wide acceptance of such programs, many producers and presenters of these events now are reaching wider audiences beyond the location of the actual presentation. Satellite communications are widely used to broadcast presentations to audiences in geographically distant locations.

Public satellite networks began to appear in the mid-1980's to serve the growing market for live, satellite events. Most of these producers were affiliated with either production companies, broadcast television companies, or specialized satellite service companies. As the number of satellite receive sites increased over the years, several organizations attempted to market public satellite downlinking for multiple sites. In this connection, with the widespread availability of satellite sites, many public schools and libraries have received satellite dishes through programs such as the federally-funded Star Schools initiative. Similarly, many state government programs have installed satellite dishes in learning institutions, and numerous hospitals and medical clinics now have satellite capability.

In addition to such public sites, a growing number of private "business television" networks have emerged in the last decade. These private networks use permanently installed satellite equipment to broadcast programs to geographically distant sites owned by the particular businesses. As would be expected, these companies broadcast primarily to internal audiences.

In the above-described satellite networks, the satellite events employ one-way video technology from the broadcast site to the remote locations. Consequently, there is limited interaction between remote program participants and the broadcast site. However, in the past five years, there has been significant growth in the use of two-way video, or videoconferencing. These systems use compressed digital video signals that are typically transmitted by telephone lines using switched 56, T-1 or ISDN service. Today, most major corporations and many colleges and universities have installed videoconferencing equipment. These organizations use videoconferencing technology for events requiring only a few sites and from 1 to 20 attendees.

To provide increased real-time interaction between persons from geographically distant locations during special events, certain presenters use two-way satellite communication. For example, national "town hall" meetings have been produced to join people from geographically distant locations for discussions on political/social issues. Typically, in these events, audiences from a few select geographical locations are linked together by satellite, with each location having the capability of both transmitting and receiving satellite signals. In certain instances, "town hall" meetings and similar events have been conducted with audience response equipment such as individual keypads for survey/polling purposes.

While the above-described methods and systems for implementing multiple site events have experienced some success, these methods suffer from important disadvantages that limit their potential. For example, videoconferencing has limited application since this technology can serve only small groups of participants in a limited number of locations. Moreover, most national "town hall" meetings or similar events require both satellite uplink and downlink systems in each location to connect the limited groups of audiences. Obviously, if an increased number of locations is desired, the cost of producing these events becomes prohibitive due to the significant monetary expenditure for technical equipment and service. Additionally, these systems experience difficulties in serving large audiences in remote locations since television monitors typically are used to display the event. Obviously, because televisions are limited in screen size, they are not feasible for displaying event information to large audiences in auditoriums and the like.

SUMMARY OF THE INVENTION

In view of the foregoing, it is a primary object of the present invention to provide an interactive network system that links a plurality of large audiences to conduct live, interactive events.

In accomplishing this objective, another object of this invention is to interactively link a plurality of motion picture theater auditoriums so that large audiences can be accommodated at locations across the country.

Yet another object of this invention is to provide an interactive theater network system that utilizes full-motion picture projection technology so that audiences throughout the theater network can view interactive event information on large movie screens.

Still another object of this invention is to allow audiences from any network theater location to participate in the interactive event and allow this participation to be broadcast to all other theater locations within the network.

A related object of the present invention is to provide an interactive communication system that allows both audio and video communications to be generated from any theater location and broadcast to all other theater locations within the network.

Yet another object of this invention is to provide an interactive communication system that allows businesses or other entities to cost-effectively conduct live, interactive events nationwide or even worldwide.

These and other important aims and objectives are accomplished with the interactive theater network system of the present invention. The system links a plurality of motion picture theater auditoriums so that live, interactive events can be conducted with theater audiences throughout the theater network. The theater network system includes an origination site for broadcasting information relating to the interactive event, and a plurality of network theater auditoriums interactively linked with the origination site. Each of these network theaters includes a full-motion picture projection system configured to receive the interactive event information from the origination site and present the information to the theater audiences. The interactive event information is transmitted from the origination site to the plurality of network theaters with a broadcast communication system. The present invention also includes an audience response system that provides interactive communication between the origination site and audience members from the plurality of network theaters. A data collection system is provided as part of the audience response system to collect

and process data relating to the interactive event that is generated from audience members in the plurality of theaters. Also, an interactive communication system provides audio and video communications during the interactive event between audience members across the network and the origination site.

BRIEF DESCRIPTION OF THE DRAWINGS

The various aspects of the invention are described in detail below, with reference to the drawings, in which:

FIG. 1 is a block diagram illustrating the interactive theater network system according to the present invention;

FIG. 2 is a schematic diagram illustrating the technical components used in the network theater locations of the interactive theater network system shown in FIG. 1;

FIG. 3 is a diagram illustrating the wireless keypads used in connection with the data collection system of the interactive theater network system; and

FIG. 4 is a block diagram illustrating the components used to collect data from audience members in network theaters according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings, an interactive theater network system for linking a plurality of motion picture theater auditoriums is broadly designated in FIG. 1 by the reference numeral 10. Interactive theater network system 10 of the present invention can be used to conduct live, interactive events by linking theater audiences from geographically distant regions located throughout the theater network. For example, theater network system 10 can be used to conduct interactive events such as business meetings, seminars, research sessions, training sessions, conferences, polling, sports viewing, "town hall" meetings, awards presentations, multi-media business presentations, interactive distance learning, etc. Thus, theater network system 10 has essentially unlimited applications in situations requiring interactive communication between large audiences from around the country and beyond.

Referring in more detail to FIG. 1, theater network system 10 includes an origination site 12 for broadcasting or transmitting the program information relating to a particular interactive event. Thus, for example, the origination site for a seminar could be a television studio or similarly-equipped location where the presenter conducts the seminar and conveys the presentation to theater audiences across theater network system 10. A plurality of network theaters 14 are shown in FIG. 1 that are interactively linked with origination site 12. As indicated in FIG. 1 by arrow 16, the present invention contemplates a significant number of network theaters within interactive theater network system 10 of the present invention. Each of the network theaters 14 includes a full-motion picture projection system configured to receive the interactive event information from origination site 12 and present the information to theater audiences. Thus, unlike videoconferencing technology which conferences small groups in a few locations on closed-circuit television, theater network system 10 interactively links virtually hundreds of locations housing large audiences for a single interactive event.

In the preferred embodiment of the present invention, a satellite communication system 18 is utilized to interactively link origination site 12 with the plurality of network theaters 14. In this case, origination site 12 employs a satellite uplink system to broadcast the program information. Satellite transmissions from origination site 12 are received by a designated satellite orbiting Earth and relayed to the selected network theaters 14 within theater network system 10. Each network theater 14 is equipped with a satellite downlink system so that the program information broadcast from origination site 12 can be received and displayed to the theater audiences.

For the purpose of securing transmissions, satellite communication system 18 includes an encryption system that encodes event transmissions at the origination site so that only authorized network theaters 14 have access to the event transmissions. In the preferred embodiment, a computer interface communicates with the encryption system at the origination site so that event presenters can designate particular theaters for receipt of the event information. Each network theater location 14 includes a decoding device for decoding the encrypted satellite signals. A suitable satellite communication system for purposes of the present invention is produced by Scientific Atlanta and includes B-MAC encoding technology.

FIG. 1 also illustrates an alternative communication system 20 for interactively linking origination site 12 and network theaters 14. Alternative communication system 20 can comprise a fiber optic communication system or a microwave communication system as alternatives to satellite communication. For example, with a fiber optic communication system, fiber optic connections are run from the network theaters to the central office of a local telephone company. The signals are transmitted across fiber optic telephone lines to the local central office in the location of the origination site. Similar fiber optic connections exist between the origination site and the local central office so that fiber optic signals can be both transmitted and received by the origination site. Thus, although the present invention contemplates the use of a satellite communication system as the preferred method of communication, any method of communication having the capability of transmitting signals containing video and audio information can be utilized in accordance with the present invention to interactively link a plurality of network theaters.

An important aspect of the present invention is the ability to provide audience response at any or all of the particular theaters in theater network system 10. The audience response system provided with the present invention allows for interactive communication between the origination site and audience members from the plurality of network theaters, as well as communication between audience members from different theater audiences within the theater network. As illustrated in FIG. 1, a data collection system 22 is used to collect and process data relating to the interactive event that is generated from audience members in the plurality of theaters. For example, in research sessions or other events where audience participation is desired, audience members are equipped with wireless keypads 24, as best illustrated in FIG. 3, to generate responsive data relating to the particular interactive event. Further details of data collection system 22 are described below in connection with FIG. 4.

Theater network system 10 also includes an interactive audio system 26 that provides two-way audio communications between audience members from multiple sites in the plurality of network theaters, and between remote audience members and the origination site while the interactive event takes place. Thus, in accordance with the present invention, an audience member participating in the interactive event at a geographically distant network theater location can com-

municate with the presenter at the origination site. Moreover, this audience communication is relayed to all other participating theaters in the theater network system.

To further enhance the interactive communication within theater network system **10** of the present invention, an interactive video return system **28** is provided. Video return system **28** supplies signals containing video information generated from any of the network theater locations and communicates these video information signals to origination site **12**. These video information signals are then broadcast by origination site **12** in real-time to the other network theaters during the interactive event. This is accomplished in the present instance by equipping each network theater **14** with a video camera so that video images of participants can be taken at any network theater location within theater network system **10**. In one implementation of the present invention, the video return system **28** utilizes a still-image video system that supplies still-image video signals from any of the network theaters and communicates the signals to the origination site for broadcast to all network theater locations. These still-image video signals can be produced by utilizing a video camera, such as a conventional camcorder, in conjunction with a special still-image phone, such as the AT&T Picasso Still-Image phone. In an alternative implementation, if upgraded telephone lines are available, video return system **28** can supply full-motion video signals of participants at any of the network theater locations and communicate these full-motion video signals to the origination site.

As shown in FIG. **1**, the plurality of network theaters **14** are interconnected to audience response systems **22**, **26** and **28** via data lines **30**. In a similar fashion, systems **22**, **26** and **28** communicate with origination site **12** via data lines **32**. In the present embodiment, data lines **30** and **32** comprise conventional telephone lines, although the data lines could comprise upgraded telephone lines such as ISDN lines.

A highly desirable feature of interactive theater network system **10** is the ability to accommodate large audiences in many theater locations nationwide or even worldwide. The venue of motion picture theaters is uniquely capable of accommodating large numbers of participants. For example, motion picture theaters typically have large auditoriums with comfortable, long-duration seating and clear sight lines to large movie screens that display the interactive event information. Moreover, the network theater locations **14** included in theater network system **10** employ the highest quality projection equipment available as described in further detail below. Also, movie theaters are already equipped with outstanding sound systems and provide limited distraction environments, unlike hotel conference rooms or other similar meeting places.

Another important advantage of theater network system **10** is the capability for presenters to select which markets to include in the network system. For example, a large corporation utilizing theater network system **10** of the present invention can essentially customize a theater network by selecting its corporate headquarters as the origination site and selecting network theaters in geographic locations where additional corporate facilities are located. Thus, the present invention provides true flexibility in creating interactive programs by allowing presenters to select from a few network locations to literally hundreds of locations.

FIG. **2** illustrates the components utilized at each network theater location to present the interactive event information to theater audiences. Each theater location is equipped with a satellite dish **34** for receiving satellite transmissions from the origination site. The satellite signals are fed into a band switch panel **36** via lines **38**. Band switch panel **36** includes a power supply **40** connected to a power block **42** which supplies power to a low noise block (LNB) associated with satellite dish **34**. A toggle switch **44** in band switch panel **36** allows satellite dish **34** to receive either C or KU band signals. Toggle switch **44** is connected to band switch **46** which allows the selected C or KU band signals to be routed to an integrated receiver/decoder **48**.

As can be seen in FIG. **2**, the satellite signals are transmitted from band switch panel **36** to the "RF IN" input of receiver **48**. Receiver **48** then produces VIDEO OUT signals and AUDIO OUT signals via channel 1 (CH 1) and channel 2 (CH 2) outputs. Additionally, receiver **48** includes an antenna polarity control **50** that controls the signal polarity for satellite dish **34**. Theater network system **10** of the present invention also includes a satellite redundancy feature to permit interactive communication when satellite transmissions are degraded. For example, during certain times of the year, the relative positioning of the Sun, the satellite, and the Earth results in an increased level of microwave radiation received from the Sun. This radiation essentially blocks or seriously degrades satellite signals. During these times, theater network system **10** utilizes live audio signals via telephone lines to supply uninterrupted communication between origination site **12** and the plurality of network theaters. Such occurrences typically last only several minutes at any particular geographic location.

Still referring to FIG. **2**, the output signals from receiver **48** are communicated to a router **52**. In addition to receiving satellite signals, router **52** receives any other signal containing video and audio information such as signals from fiber optics, high definition television, laser disc, etc. As shown in FIG. **2**, the VIDEO OUT output from receiver **48** is connected to the VIDEO IN2 input of router **52**, and the CH 1 and CH 2 audio outputs from receiver **48** are received by the AUDIO 1 and 2 inputs of input IN2. The IN1 video and audio inputs are connected to a video/audio test output generator **54** shown as part of distribution amplifier **56** in FIG. **2**. Router **52** includes a number of video and audio inputs, and as shown in FIG. **2**, up to ten inputs.

The output signals from router **52** are received by the AUDIO IN and VIDEO IN inputs of distribution amplifier **56**. Distribution amplifier **56** then distributes the audio and video output signals to the particular theater auditoriums selected to receive and display the interactive event information. As shown in FIG. **2**, distribution amplifier **56** has up to eight audio and video outputs, although this number is only illustrative. As can be seen, the VIDEO OUT 1 and AUDIO OUT 1 outputs of distribution amplifier **56** are received by a projection booth monitor and speaker **58** so that projection booth personnel can monitor the interactive event information displayed in the theater auditoriums.

As illustrated in FIG. **2**, VIDEO OUTPUT 2 and AUDIO OUTPUT 2 of distribution amplifier **56** are routed to Theater 1 of the particular network theater. These signals are run to an audio/video wall panel **60** located in the projection booth of the theater. A projection system **62** is then connected to audio/video wall panel **60** so that projection system **62** can display the interactive event information on movie screen **64**.

A highly advantageous feature of theater network system **10** is the capability of presenting high-resolution, full-motion video projection images on large movie screens to theater audiences. This capability is far superior to existing systems that utilize television technology for displaying

broadcasts to conference participants. In the illustrated embodiment, a Hughes/JVC Model 320 video projector is used to display the interactive event information to theater audiences. It will be appreciated that other state-of-the-art systems employing high quality video projection technology (such as light valve or digital micro-mirror device (DMD) technology) can be used in accordance with the present invention. In most cases, the projection system utilizes a line doubler such as the Faroudja System LD100 to provide a higher resolution picture on the movie screens. Generally, any NTSC signal runs through the line doubler before it is received by the video projector. However, high definition television signals run directly into the projector without the use of the line doubler. This is also the case for most on-site computer signals.

FIG. **4** illustrates the manner in which data is collected from audience members in accordance with theater network system **10**. Within each network theater auditorium **66**, audience members are supplied with audience response keypads **24**. As shown in FIG. **3**, audience response keypads **24** include an alphanumeric keypad **68** so that audience members can key-in data at appropriate times during an interactive event. While FIG. **4** only shows three audience response keypads **24**, it should be understood that large numbers of keypads **24** can be used for data collection as represented by arrow **69**. The radio frequency (RF) signals transmitted by audience response keypads **24** are collected by an RF collector **70** located substantially near the back wall of each theater auditorium. To avoid missing any RF signals within the theater auditorium, antennas **72** and **74** are spaced apart from RF collector **70** to capture all signals. Suitable audience response keypads and RF collector equipment include Model CRS1200 cordless keypads and CRS950 interfaces produced by the Fleetwood Furniture Company of Holland, Mich.

The signals received by RF collector **70** are processed and transmitted to a personal computer **76** stationed in a projection booth **78** of each network theater. A suitable personal computer is an IBM PS/2 Model 65 or similarly-equipped PC. Personal computer **76** processes the data generated from audience members related to the interactive event and transmits the data to a host computer **79**.. The host computer **79** accepts data from each participating network theater location and transmits data for each theater to an origination site computer **80** via standard modem line **82**.

In keeping with the ability to serve large audiences across a large number of network theaters, theater network system **10** in the illustrative embodiment can accept data from up to **250** keypads per network theater location in a single network. Thus, up to 250 keypad signals are received, processed, and communicated to the origination site for substantially instantaneous tabulation of results. These tabulated results are then broadcast by origination site **12** to the entire theater network. In instances where only a single theater is used as opposed to a network of theaters, system **10** can accept up to 1000 keypad signals for a single location. Furthermore, in situations where more than 250 keypad signals are required per network theater location in a networking situation, theater network system **10** can accept more than 250 keypad signals per location and store these signals for later processing and tabulation of results.

Another desirable feature of theater network system **10** according to the present invention is the capability of allowing a client to monitor a program such as a blind research session from its corporate offices. For example, if a corporation chooses to conduct training or research sessions with a large number of corporate employees across the country, corporate management can monitor the national research session with a special theater arrangement. Specifically, instead of displaying results to all participants, the collected and processed data can be tabulated and sent directly to the corporate offices. In this situation, corporate management accepts the satellite signals from the origination site similar to all network theater locations, and the tabulated results from collected data is transmitted via modem only to the corporate site.

For real-time data collection during interactive events, each computer at the network theater locations operates in a "dummy" mode for data collection only. Each theater computer communicates with host computer **79** which then transmits to the origination site computer **80** via modem line. The origination site computer **80** is used to display the text of questions or other data used for the particular interactive event. Origination site computer **80** lists particular questions, and also informs the remote computers in the network theater locations to accept data from wireless keypads **24**. Then, for the next question or text display, origination site computer **80** directs the next question to be displayed, and also directs the remote computers to stop collecting data for the previous question, send the collected data for the previous question to origination site computer **80**, and begin collecting data for the next question. The text of each question can also be displayed on the screen to the audience participants along with the tabulated results. Additionally, incorrect answers input by particular users will be noted as well as the identification of users that do not respond.

As discussed above, a significant aspect of the interactive nature of theater network system **10** is the ability to provide two-way audio and video communications across the theater network. In the illustrated embodiment, a modified phone bridging system is utilized to provide the video capability. This is due to the fact that video phones can only interact in a point-to-point environment. If the bridge lines are open to all locations, when one remote phone attempts to communicate with the origination site, the communications are also received by the phones at the other remote locations. Because modems are involved, significant problems occur as each remote phone line receives the modem connect signals along with the video signals that are only intended for the origination site. To overcome these problems, the present invention stations an operator at the modified phone bridge to patch particular callers through to the origination site to provide the audio and still-image video signals. When the particular phone location is connected to the origination site, all other video and audio transmission systems from the other remote locations are disabled. The phone bridge operator is directed by personnel involved with operating the particular interactive event regarding which particular network theater to patch into the origination site at a given time.

In keeping with the invention, the tabulated data processed by data collection system **22** can be provided to clients in an expeditious manner in a variety of formats such as hardcopy, modem transmission, or computer disk. For example, the data files can be provided in an ASCII format, an RF file, and an Excel format. Generally, the tabulated data is displayed in a column/row format, with each column representing responses to a particular question and each row representing the particular keypad that provided responses.

A desirable feature related to data collection is the ability to support ad hoc questioning. Typically, all of the questions for a research session, for example, are pre-programmed. However, theater network system **10** provides the capability of soliciting responses to additional questions on an ad hoc

basis and storing both the collected data and the text of the ad hoc questions.

Another important advantage of theater network system **10** relates to market pricing. The present invention offers significant cost savings advantages, since it would cost a client renting the equipment necessary to provide a similar network system for interactive events a significantly greater amount than is required by users of theater network system **10**.

In addition to providing interactive research sessions, business meetings, etc., theater network system **10** can be used for other important applications. For example, theater network system **10** can be used to significantly assist in the production and distribution of motion picture films. Typically, a motion picture is filmed using both film and videotape. The film and the videotape include time codes interspersed throughout the frames that are synchronized between the film and the videotape. During the editing process, motion picture companies normally edit the videotape first, and then edit the film based on the synchronized time codes placed on both the film and the videotape. Once the film is edited, it is provided to test screen sites and screened by audiences for potential changes or general approval prior to wide distribution. Both the film and the videotape are edited as many times as required to complete the film to the satisfaction of those involved with the production.

Theater network system **10** can significantly reduce the time and procedures involved in film production. In connection with the present invention, the videotape used in filming the motion picture is converted to high-definition signals or other video formats. These video files are then transmitted across the theater network system via satellite or fiber-optic lines to select groups of theater audiences. These theater audiences can screen the video files and provide responses relating to the movie with the interactive audience response system of the present invention. Then, the motion picture company need only edit the videotape version following audience screening and, if necessary, rescreen the videotape as necessary using the theater network system without editing the original film version. Once the video format is in the desired condition, the film can then be edited only once and then sent out for wide distribution to movie theaters. This capability certainly provides a tremendous savings in both time and costs in relation to motion picture production.

As is evident from the foregoing description, the theater network system of the present invention allows a plurality of motion picture theater auditoriums to be interactively linked so that live, interactive events can be conducted with large theater audiences throughout the theater network. The present invention provides full-motion picture projection capability to the theater audiences across the theater network, and allows real-time audience participation through data collection, audio communication, and video communication.

While this invention has been described with an emphasis upon a preferred embodiment, it will be understood by those of ordinary skill in the art that variations of the preferred embodiment may be used and that it is intended that the invention may be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications encompassed within the spirit and scope of the invention as defined by the following claims.

We claim:

1. An interactive theater network system for linking a plurality of motion picture theater auditoriums to conduct live, interactive events with theater audiences throughout the theater network, the theater network system comprising:

an origination site for broadcasting information relating to the interactive event;

a plurality of network theater auditoriums interactively linked with the origination site, each of the theaters including a full-motion picture projection system configured to receive the interactive event information from the origination site and present the information to theater audiences;

a broadcast communication system for transmitting the interactive event information from the origination site to the plurality of network theaters; and

an audience response system for providing interactive communication between the origination site and audience members from the plurality of network theaters, the audience response system including

data collection means for collecting and processing data relating to the interactive event generated from audience members in the plurality of theaters, and

interactive communication means for providing two-way audio and video communications during the interactive event between audience members from multiple sites in the plurality of network theaters and between audience members and the origination site.

2. The interactive theater network system as defined in claim **1** wherein the broadcast communication system comprises a satellite communication system.

3. The interactive theater network system as defined in claim **2** wherein the satellite communication system includes a satellite transmission device located at the origination site and satellite receiving devices located at the plurality of network theaters for receiving the interactive event information from the satellite transmission device.

4. The interactive theater network system as defined in claim **3** wherein the satellite communication system includes encryption means for encoding event transmissions so that only authorized network theaters have access to the event transmissions.

5. The interactive theater network system as defined in claim **1** wherein the broadcast communication system transmits information via fiber optic communication or microwave communication.

6. The interactive theater network system as defined in claim **1** wherein the interactive events include research sessions, business meetings, seminars, multi-media presentations, training, and conferences.

7. The interactive theater network system as defined in claim **1** wherein the data collection means includes wireless keypads provided to theater audience members for generating response data relating to the interactive event information, and RF collection means for receiving RF signals generated by the wireless keypads during data collection.

8. The interactive theater network system as defined in claim **7** wherein the data collection means further includes computer means for receiving the data generated by the audience members, processing the collected data, and communicating the processed data in substantially instantaneous time to the origination site for broadcast to the plurality of network theaters.

9. The interactive theater network system as defined in claim **1** wherein the interactive communication means comprises:

audio communication means for providing two-way audio communication between audience members from mul-

tiple sites in the plurality of network theaters and between audience members and the origination site; and

video communication means for supplying signals containing video information from any of the plurality of network theaters and communicating said signals to the origination site so that said signals can be broadcast to the plurality of network theaters during the interactive event.

10. The interactive theater network system as defined in claim 9 wherein the video communication means comprise still-image video means for supplying still-image video signals generated from any of the plurality of network theaters to the origination site.

11. The interactive theater network system as defined in claim 9 wherein the video communication means comprises interactive full-motion video means for supplying full-motion video signals generated from any of the plurality of network theaters and communicating the full-motion video signals to the origination site.

12. An interactive theater network system for linking a plurality of motion picture theater auditoriums to conduct live, interactive events with theater audiences throughout the theater network, the theater network system comprising:

an origination site for broadcasting information relating to the interactive event;

a plurality of network theater auditoriums interactively linked with the origination site, each of the theaters including a full-motion picture projection system configured to receive the interactive event information from the origination site and present the information to theater audiences;

a satellite communication system for communicating the interactive event information from the origination site to the plurality of network theaters;

a data collection system for collecting data relating to the interactive event from audience members in the plurality of theaters, processing the collected data, and communicating with the origination site to broadcast the processed data to the plurality of network theaters during the interactive event;

an interactive communication system for providing two-way audio communication between audience members from multiple sites in the plurality of network theaters and between audience members and the origination site during the interactive event; and

an interactive video system for supplying signals containing video information generated from any of the plurality of network theaters and communicating the video information signals to the origination site so that the video information signals can be broadcast to the plurality of network theaters during the interactive event.

13. The interactive theater network system as defined in claim 12 wherein the satellite communication system includes a satellite transmission device located at the origination site and satellite receiving devices located at each of the plurality of network theaters for receiving the interactive event information from the satellite transmission device.

14. The interactive theater network system as defined in claim 13 wherein the satellite communication system includes encryption means for encoding event transmissions so that only authorized network theaters have access to the event transmissions.

15. The interactive theater network system as defined in claim 12 wherein the interactive events include research sessions, business meetings, seminars, multi-media presentations, training, and conferences.

16. The interactive theater network system as defined in claim 12 wherein the data collection system includes wireless keypads provided to theater audience members for generating response data relating to the interactive event information, and RF collection means for receiving RF signals generated by the wireless keypads during data collection.

17. The interactive theater network system as defined in claim 16 wherein the data collection system further includes computer means for receiving the data generated by the audience members, processing the collected data, and communicating the processed data in real-time to the origination site for broadcast to the plurality of network theaters.

18. The interactive theater network system as defined in claim 12 wherein the interactive video system supplies still-image video signals generated from any of the plurality of network theaters and communicated to the origination site.

19. The interactive theater network system as defined in claim 12 wherein the interactive video system supplies full-motion video signals generated from any of the plurality of network theaters and communicated to the origination site.

20. A method of interactively linking a plurality of motion picture theaters to provide a theater network for conducting live, interactive events with theater audiences throughout the theater network, the method comprising:

broadcasting information relating to the interactive event from a network origination site;

providing a plurality of network theater auditoriums each including a full-motion picture projection system configured to receive the interactive event information from the origination site and present the information to theater audiences;

interactively linking the plurality of network theaters and the origination site with a broadcast communication system that communicates the interactive event information from the origination site to the plurality of network theaters;

collecting and processing data relating to the interactive event from audience members in the plurality of network theaters;

communicating the processed data to the origination site for broadcast to the plurality of network theaters during the interactive event;

providing two-way audio communication between audience members from multiple sites in the plurality of network theaters and between audience members and the origination site during the interactive event; and

producing signals containing video information from the plurality of network theaters and communicating the video information signals to the origination site so that the video information signals can be broadcast to the plurality of network theaters during the interactive event.

21. The method as defined in claim 20 wherein the broadcast communication system comprises a satellite communication system.

22. The method as defined in claim 21 wherein the satellite communication system includes a satellite transmission device located at the network origination site and satellite receiving devices located at the plurality of network theaters for receiving the interactive event information from the satellite transmission device.

23. The method as defined in claim 22 wherein the satellite communication system includes encryption means for encoding event transmissions so that only authorized network theaters have access to the event transmissions.

24. The method as defined in claim 20 wherein the broadcast communication system transmits information via fiber optic communication or microwave communication.

25. The method as defined in claim 20 wherein the interactive events include research sessions, business meetings, seminars, multi-media presentations, training, and conferences.

26. The method as defined in claim 20 wherein the collecting and processing of data includes providing wireless keypads to theater audience members for generating response data relating to the interactive event information, and providing RF collection means for receiving RF signals generated by the wireless keypads during data collection.

27. The method as defined in claim 26 wherein the collecting and processing of data includes utilizing computer means for receiving the data generated by the audience members, processing the collected data, and communicating the processed data in real-time to the network origination site for broadcast to the plurality of network theaters.

28. The method as defined in claim 20 wherein the video information signals comprise still-image video signals generated from any of the plurality of network theaters and communicated to the network origination site.

29. The method as defined in claim 20 wherein the video information signals comprise full-motion video signals generated from any of the plurality of network theaters and communicated to the network origination site.

30. The interactive theater network system as defined in claim 1 wherein the interactive events include client monitoring and the data collection means further includes computer means for receiving the data generated by the audience members, processing the collected data, and communicating the processed data in substantially instantaneous time to a corporate office location.

31. The interactive theater network system as defined in claim 1 wherein the interactive events include screening motion picture films.

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US006141530A

United States Patent [19]

Rabowsky

[11] Patent Number: 6,141,530

[45] Date of Patent: Oct. 31, 2000

[54] SYSTEM AND METHOD FOR DIGITAL ELECTRONIC CINEMA DELIVERY

[75] Inventor: Irving Rabowsky, Woodland hills, Calif.

[73] Assignee: Digital Electronic Cinema, Inc., Los Angeles, Calif.

[21] Appl. No.: 09/094,615

[22] Filed: Jun. 15, 1998

[51] Int. Cl.[7] H04H 1/00

[52] U.S. Cl. 455/3.1; 455/4.1; 455/4.2; 709/217; 348/7; 348/12; 348/13; 348/436

[58] Field of Search 455/3.1, 4.2; 709/217; 348/436, 13

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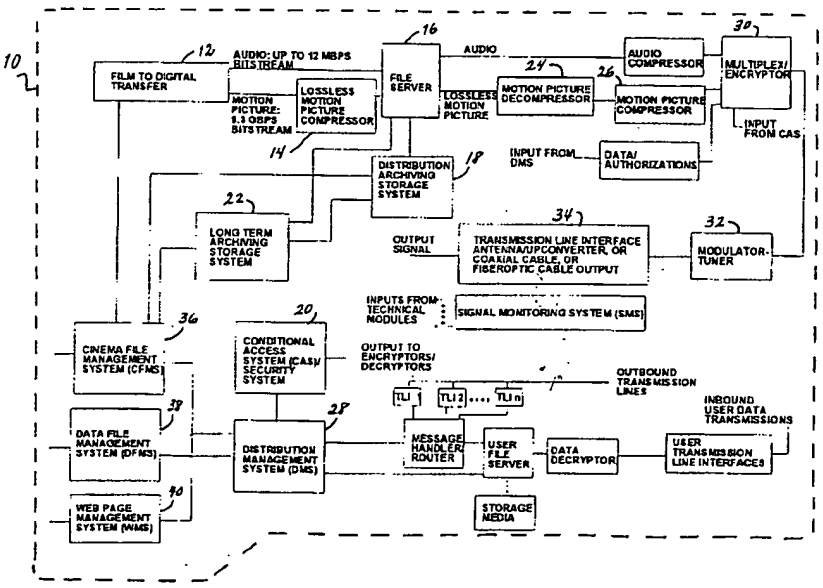
Primary Examiner—Andrew I. Faile
Assistant Examiner—Sam Huang
Attorney, Agent, or Firm—Oppenheimer Wolff & Donnelly, LLP.

[57] ABSTRACT

A novel system and method for secure electronic delivery of motion pictures in digital format to many end users simultaneously. In particular, the system comprises a headend system and a theater system. The headend system comprises a baseband processing system which receives analog cinema film as input, a storage system which receives digitized cinema files from the baseband processing system, a radio frequency transmission system which communicates cinema and data files to and from various users as a radio frequency bit stream, and a management system which controls transmission and storage of cinema and data files. The theater system comprises transmission line interfaces at theaters designated to receive cinema and data files from the headend system, receiver-decoders which receive the radio frequency bit stream and produce decoded cinema and data files at baseband, storage playback systems which stores cinema and data files until needed, secure projector systems which playback cinema files, an automation/scheduling system which directs playback of cinema files in the secure projector systems as authorized by the management system, and a reverse channel which provides data back to the headend system from the theaters. A preferred version of the present invention further comprises a creator/editor's system which allows authorized viewing and editing of cinema files by creators and editors. The creator/editor's system provides capability for editing and baseband processing of cinema files at remote locations, and transmits edited cinema files back to the headend system.

5 Claims, 4 Drawing Sheets

Claim 1
Digital Film
Claim 2 Reverse Channel
(Back Channel)



Headend

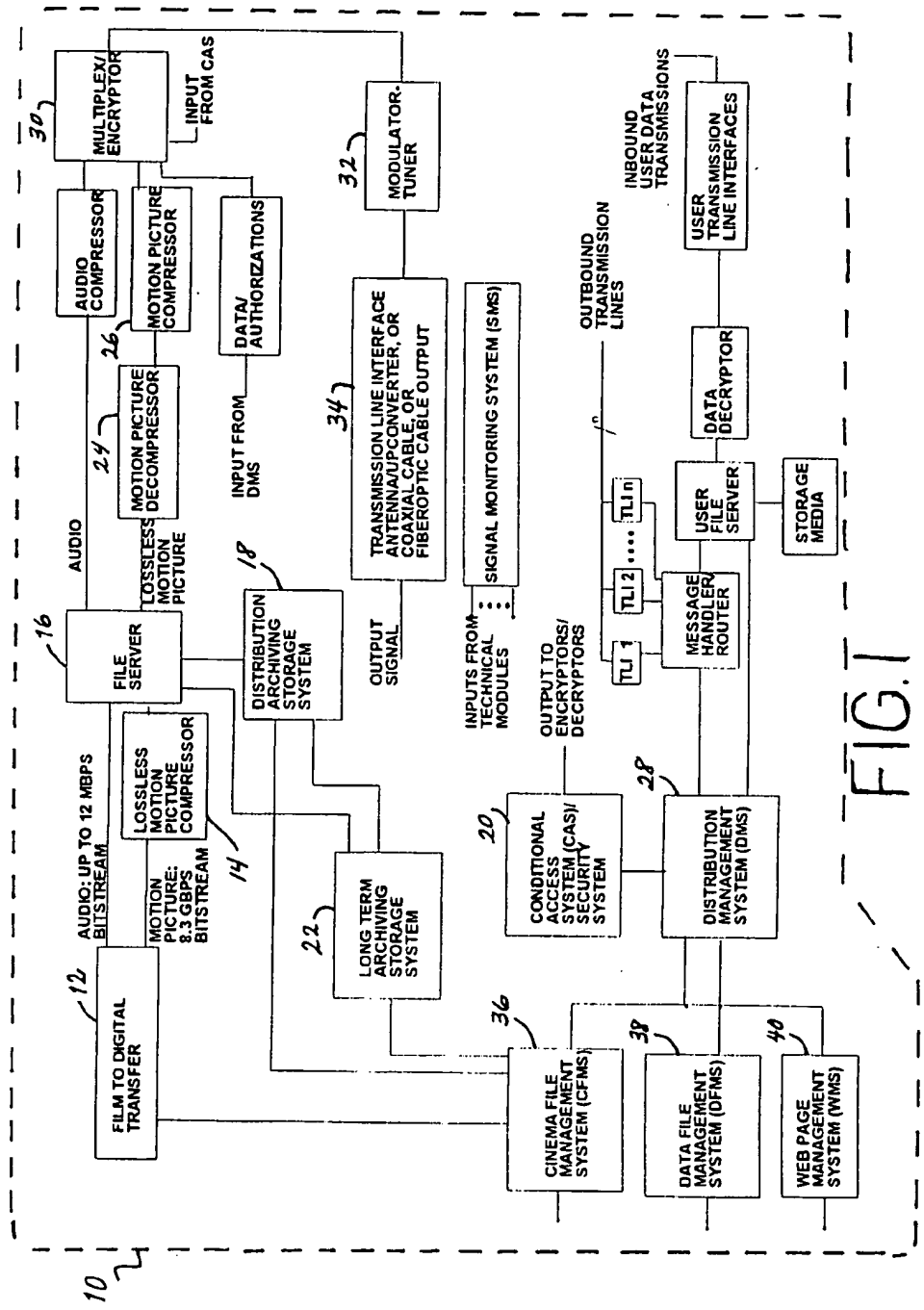

10
Headend
12
FILM TO DIGITAL TRANSFER
AUDIO: UP TO 12 MBPS BITSTREAM
MOTION PICTURE: 8.3 GBPS BITSTREAM
14
LOSSLESS MOTION PICTURE COMPRESSOR
16
FILE SERVER
AUDIO
LOSSLESS MOTION PICTURE
18
DISTRIBUTION ARCHIVING STORAGE SYSTEM
22
LONG TERM ARCHIVING STORAGE SYSTEM
24
MOTION PICTURE DECOMPRESSOR
26
MOTION PICTURE COMPRESSOR
AUDIO COMPRESSOR
30
MULTIPLEX/ ENCRYPTOR
INPUT FROM CAS
DATA/ AUTHORIZATIONS
INPUT FROM DMS
32
MODULATOR-TUNER
34
TRANSMISSION LINE INTERFACE ANTENNA/UPCONVERTER, OR COAXIAL CABLE, OR FIBEROPTIC CABLE OUTPUT
OUTPUT SIGNAL
SIGNAL MONITORING SYSTEM (SMS)
INPUTS FROM TECHNICAL MODULES
20
CONDITIONAL ACCESS SYSTEM (CAS)/ SECURITY SYSTEM
OUTPUT TO ENCRYPTORS/ DECRYPTORS
28
DISTRIBUTION MANAGEMENT SYSTEM (DMS)
OUTBOUND TRANSMISSION LINES
TLI 1
TLI 2
TLI n
MESSAGE HANDLER ROUTER
INBOUND USER DATA TRANSMISSIONS
USER TRANSMISSION LINE INTERFACES
DATA DECRYPTOR
USER FILE SERVER
STORAGE MEDIA
36
CINEMA FILE MANAGEMENT SYSTEM (CFMS)
38
DATA FILE MANAGEMENT SYSTEM (DFMS)
40
WEB PAGE MANAGEMENT SYSTEM (WMS)

FIG. 1

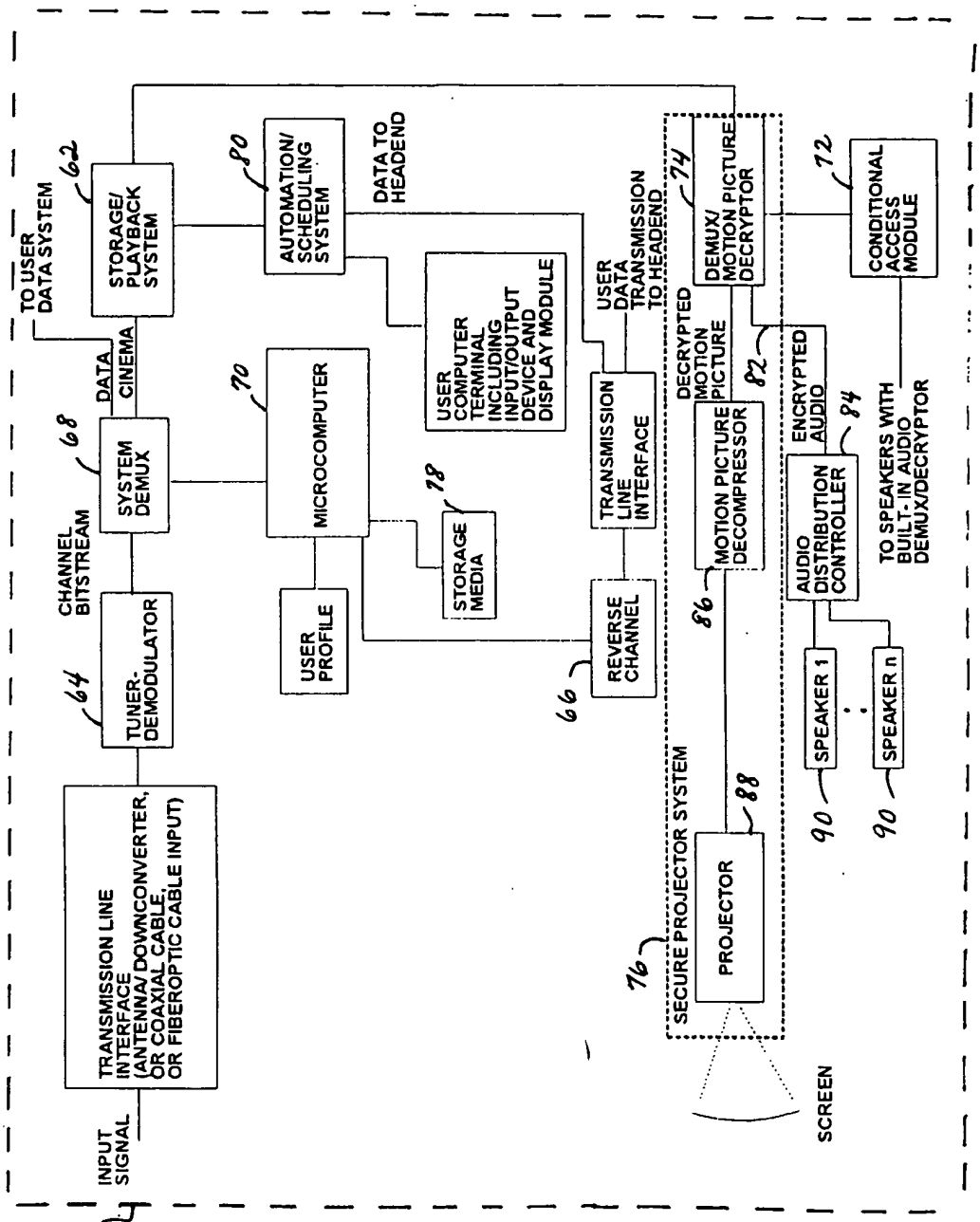


FIG. 2
Theater

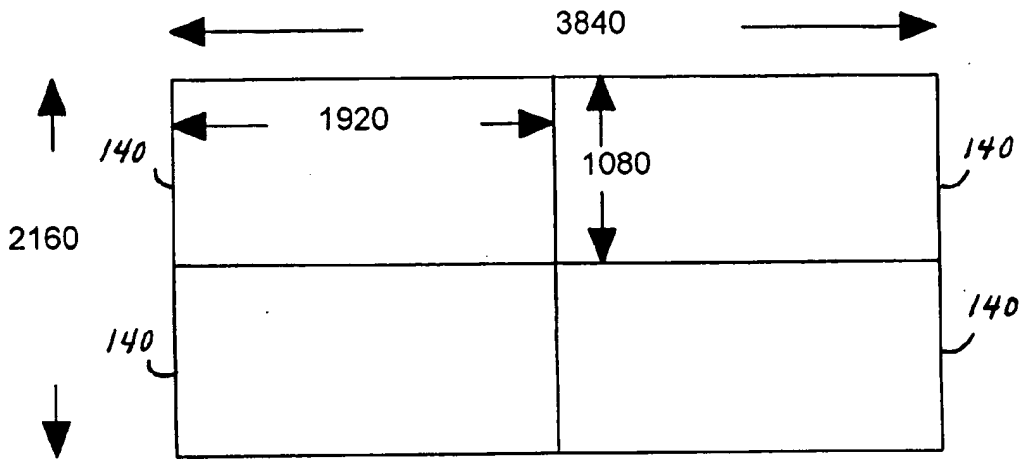


FIG. 3

Tiling Arrangement for Projector System

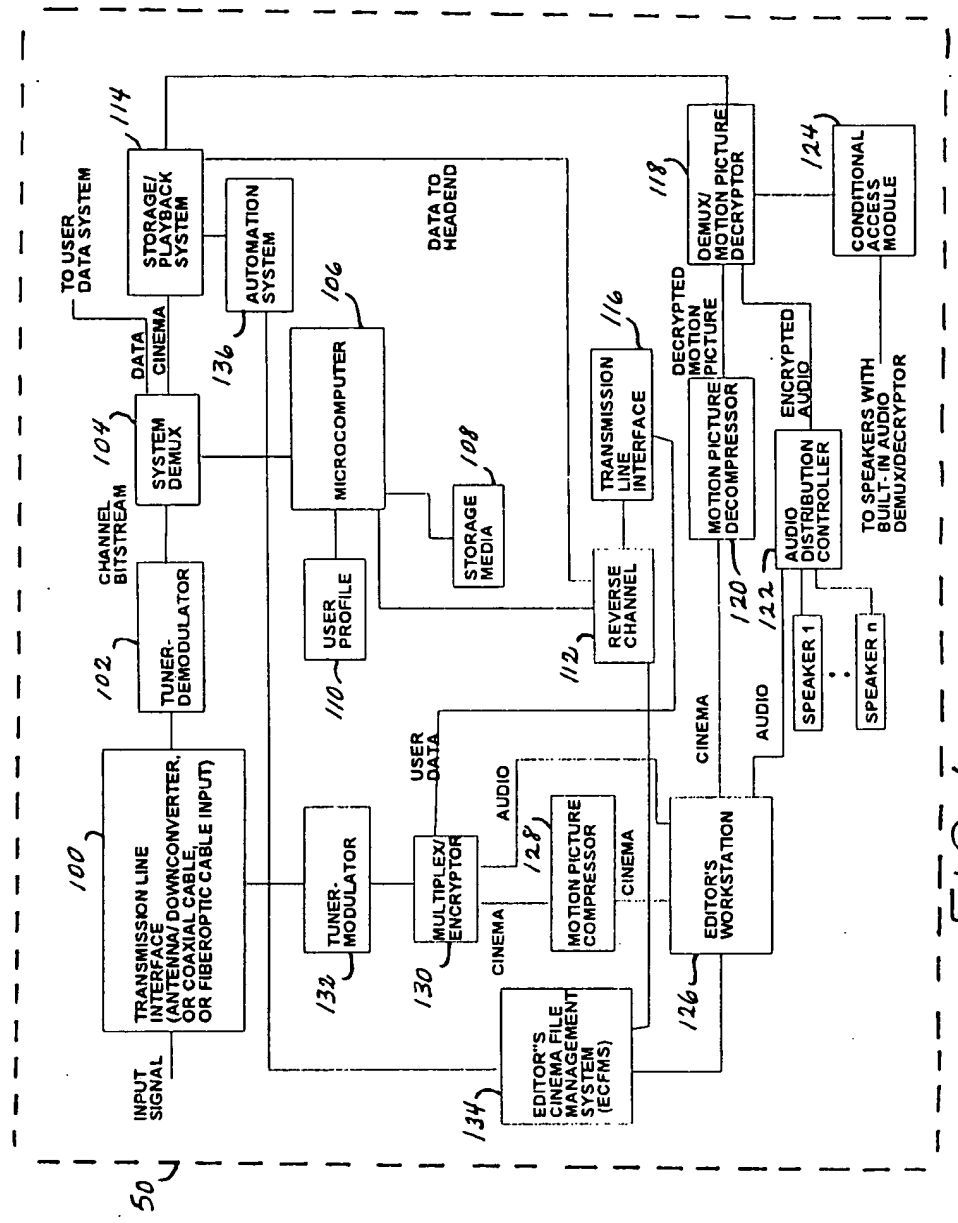


FIG. 4 Creator/Editors System

SYSTEM AND METHOD FOR DIGITAL ELECTRONIC CINEMA DELIVERY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention concerns delivery of motion pictures for exhibition. Specifically, this invention relates to a system and method for secure electronic delivery of motion pictures in digital format to many end users simultaneously.

2. Description of the Related Art

The current method of delivery of motion pictures for exhibition is to take the original film negative and make duplicate film prints in quantity sufficient to meet the schedule of exhibition. For each motion picture there are potentially many thousands of exhibitors worldwide. After many prints are made, they are distributed to the exhibitors via transportation means such as trucks. Each print is then installed into an optical-mechanical film projector which displays the print on a movie screen.

This conventional delivery method suffers from several disadvantages. First, there are many opportunities for piracy (unauthorized copying) due to the fact that many prints are made and distributed, and the film owner has, as a practical matter, little control over the prints after they are distributed. Second, the prints are expensive to make as they require costly photochemical lab processes and print stock. Third, conventional transportation means such as trucks are expensive, and may require several days or even weeks to complete a delivery cycle. Fourth, keeping track of the prints is extremely burdensome. Fifth, editing of the film after release is costly due to the cost of making new additional prints, and the logistics of distribution. By contrast, digital electronic cinema files are easily edited using computer technology. In addition, a digital electronic cinema may be customized to audience preferences, be provided in several versions with different MPAA ratings, and restricted geographically or by other criteria.

What is needed is a technology focused on the of delivery of motion pictures to theaters electronically, completely changing the delivery system presently employed by the motion picture industry from its present photochemical-mechanical technology to an entirely new digital electronic technology.

SUMMARY OF THE INVENTION

The present invention satisfies this need by providing studio distribution/exhibition and ancillary markets with a complete end-to-end integrated delivery/display system for secure digital electronic cinema. In particular, the system of the present invention comprises a headend system and a theater system. The headend system comprises a baseband processing system which receives analog cinema film as input, a storage system which receives digitized cinema files from the baseband processing system, a radio frequency transmission system which communicates cinema and data files to and from various users as a radio frequency bit stream, and a management system which controls transmission and storage of cinema and data files.

The theater system comprises transmission line interfaces at theaters designated to receive cinema and data files from the headend system, receiver-decoders which receive the radio frequency bit stream and produce decoded cinema and data files at baseband, storage playback systems which stores cinema and data files until needed, secure projector systems which playback cinema files, an automation/scheduling system which directs playback of cinema files in the secure projector systems as authorized by the management system, and a reverse channel which provides data back to the headend system from the theaters.

A preferred version of the present invention further comprises a creator/editor's system which allows authorized viewing and editing of cinema files by creators and editors. The creator/editor's system provides capability for editing and baseband processing of cinema files at remote locations, and transmits edited cinema files back to the headend system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a preferred version of a headend system embodying the present invention.

FIG. 2 is a block diagram of a preferred version of a theater system embodying the present invention.

FIG. 3 is a diagram of a preferred version of a tiling arrangement for a projector system embodying the present invention.

FIG. 4 is a block diagram of a preferred version of a creator/editor's system embodying the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The overall system architecture of the present invention comprises three main systems. Referring to FIG. 1, the first system is the Headend System, which performs baseband processing and storage of digitized cinema files, radio frequency transmission of cinema and data files to various users, and management of cinema files and databases. Referring to FIG. 2, the second system is the Theater System, which comprises transmission line interfaces at theaters designated to receive cinema and data files, receiver-decoders, storage playback systems, secure projector systems, automation/scheduling systems, and a reverse channel which provides data back to the headend from the theaters. Referring to FIG. 4, the third system is the Creator/Editor's System. This system, which allows authorized viewing and editing of cinema files by creators and editors, includes many of the same subsystems as the Theater System. However, the Creator/Editor's System further includes subsystems which provide capability for editing and baseband processing of cinema files at remote locations, and allows transmission of cinema files back to the headend.

A. Headend System

1. Baseband Processing and Storacie of Digitized Cinema Files

The present invention utilizes the existing film capture production process up through the completion of the original camera negative. The first step is to input the negative into a high resolution film scanner which digitizes the negative picture element (pixel) by picture element. This digitization retains all of the information of the original camera negative, so that the digital representation can be used for archiving and multi-generation editing. The present invention accommodates all the various film formats and aspect ratios, including but not limited to 8 millimeter, 16 mm, and 35 mm film formats, and 1.33,1.37, 1.66, and 1.85 aspect ratios.

The digitized original camera negative file is then compressed utilizing a lossless compression technology. This ensures that the motion picture image can be efficiently archived without loss of any information. By way of example but not of limitation, if a compression ratio of 6 to 10 is used for this lossless compression, then 0.3 to 0.5

terabytes are required per hour of movie for storage with archival quality.

In a preferred version of the present invention, the original camera negative film is converted into a digitized format. Because of the ever-present problem of piracy, the digital motion picture image file is encrypted before transfer to the digital electronic cinema headend. The digital motion picture image file is decrypted before being processed by the lossless compressor.

Audio may be recorded in analog or digital format, and is available from magnetic tape masters or optical or magnetic tracks on the film. Sound tracks may recorded for each speaker of multi-speaker theatrical systems. For example, in a preferred version of the present invention involving a 16 speaker theater system, capacity for 16 audio channels is allocated utilizing a 64 KHz sampling rate and a dynamic range of 20 bits per channel, that is, 1.28 mbps per channel. Thus, for 16 channels the real time transmission or storage requirement is 9.2 gigabytes per hour. To prevent piracy, security must be provided for analog audio masters and the digital audio masters. For that reason, the digital audio files are encrypted

The audio archiving system in a preferred version of the present invention provides capacity for storage of multiple languages as required. For example, a multiplex theater exhibitor may have two screens, one with English audio, and a second with Spanish audio. Audio is normally archived uncompressed, as significant artifacts are created with even modest compression.

A file server controls the flow of files to and from the previously described elements as well as a Distribution Archiving Storage System. The file server includes the following functions:

1. Encryption of the lossless motion picture image file and the digitized audio file under direction of a Conditional Access System (described below), if required.
2. Management of storage of the motion picture image and audio files, together with all timing and program associated data, onto the archiving storage system.
3. Playback of the stored cinema files from the archiving storage system.
4. Decryption of the cinema files into lossless motion picture image and audio files.

The distribution archiving storage system stores a number of lossless motion picture image files and audio files and is able to playback on demand motion picture image and audio files. Safeguards such as 1:1 redundant fail safe protection can be included. Due to practical limitations on the amount of available storage capacity, at any given time the headend will only store in the distribution archiving storage system the cinema files to be distributed over a period of several weeks. Therefore, system design includes choosing a period of time in which each motion picture is to be archived at the headend, and a method for disposition of the file when the storage/distribution period ends.

A long-term archiving storage system is required by the motion picture industry to preserve original, contribution quality digital cinema files for use by future exhibitors or historians. A preferred version of the headend provides this capability. The long-term archiving storage system retains a copy of every digital electronic cinema motion picture image and audio file in the form of lossless compressed digital motion picture image files. All cinema files are stored, in encrypted form, in a fail safe storage system. To provide user access to the long-term archiving system, a Web page, for example, may be used as a user interface.

Upon retrieval from an archive, each motion picture image file is decompressed. Then, to facilitate distribution, lossy compression is used to provide a compression ratio of, for example, about 100:1, resulting in a compressed motion picture image file, which can be transmitted utilizing a much lower bandwidth then would otherwise be required without lossy compression.

The audio file is compressed utilizing, for example, DTS or MPEG Advanced Audio Coding (AAC) algorithm. The AAC algorithm provides efficient coding of monaural, stereo, and multichannel audio. The AAC can achieve reduction of audio files by a factor of 10:1.

In addition to the audio and motion picture image files, program-associated data and conditional access information, such as authorizations and messages to and from exhibitors and users, are either retrieved from the archiving system, or received from the distribution management system (described below).

After lossy compression, the motion picture image, audio, and data are then forwarded to the multiplexor which packetizes the incoming bit streams, and forms the packets into a serial multiplexed bitstream similar to, for example, the format of the System Layer of MPEG2. Each packet in the bitstream is then encrypted with a very powerful encryption algorithm. One technical approach to encryption is to utilize an encryption technology such as triple Data Encryption Standard (Triple DES) which uses a 112 bit key. An alternate approach is to use the Digital Video Broadcast (DVB) standard, which has been widely adopted. The Conditional Access System provides the instructions to the conditional access engine in the multiplexor/encryptor, which in turn enables the encryptor. The output of the multiplexor/encryptor is a secure bit stream, which is then input to the modulator/tuner.

2. Radio Frequency Transmission

The specifications of the modulator/tuner depend upon the transmission media chosen for distribution. One preferred version of the present invention uses satellite transmission for distribution to theaters. The following discussion is based upon this selection. However, alternative transmission media such as microwave, coaxial cable, and fiberoptic cable can be used for delivery of digital electronic cinema to classes of users.

At present, channel coding for satellite transmission of digital TV utilizes QPSK modulation, with rate ½ to rate ⅚ convolutional coding and Reed Solomon forward error correction. With these technologies the net bits per symbol is about 1.7, and the coding gain is about 4.5 dB, resulting in a threshold Eb/No at the receiver demodulator of about 5.5 dB. Recent advances in coding technology have led to an effort by many companies to bring into production a 16PSK modulation, with rate ¾ trellis code, thus achieving a net of 3 bits per symbol, and a coding gain of about 6.6 dB. This new modulator design is predicted to achieve equivalent receiver threshold of about 5.5 dB, but with over a one-third reduction in occupied bandwidth. Thus a 96 Mbps modulator will require about 32 MHz of bandwidth. Other channel coding techniques, well-known to those skilled in the art, can be used in the present invention.

The tuner may provide, for example, a L Band output having a carrier which is chosen to provide the authorized satellite transponder frequency after upconversion by the upconverter module (which follows the tuner). The carrier output frequency is electronically programmable, and is assigned by the broadcast operations module of a Distribution Management System (described below).

If a satellite transmission medium is used, the satellite uplink transmission system may comprise an upconverter, an interfacility link (between the modulator/tuner and the

upconverter), a power amplifier, and an uplink antenna. It is desirable to use small antenna "dishes" at the theaters to avoid governmental regulation problems, security issues, and construction and antenna costs associated with large dishes. For these reasons, as well as C band frequency congestion problems, a preferred version of the present invention uses Ku band link implementation, which allows use of smaller dishes. However, due to the higher hourly transponder costs and significantly higher rain attenuation of Ku band links, other versions of the present invention may use lower frequency links. The antenna dish sizes for the uplink and the downlink are chosen based on the link reliability objective, and the power output of the chosen high power amplifier. It is expected the antennas will be sized for a reliability of 99.99% availability, resulting in a Ku band uplink antenna size of about 7 meters in diameter, and a Ku band downlink antenna size of about 1.2 meters.

In a Ku band uplink system, for example, an incoming L band signal from the modulator/tuner, which is within the frequency band 950 to 1450 MHz, is upconverted to the frequency band 14.0 to 14.5 GHz. The output of the upconverter is amplified by a Ku band power amplifier. A four port orthomode transducer is then used in conjunction with a switching system to provide uplink capability in either right or left hand polarization, together with the ability to receive the downlink signal for signal monitoring and performance verification.

Uplink signal power level is electronically controlled to provide automatic modification of uplink power during uplink rain fades. The objective is to keep the uplink signal strength constant at the input to the satellite transponder receiver. If the uplink signal uses an entire transponder, a transponder with automatic level control is preferred. The electronics modules of the uplink system preferably have 1:1 redundancy and automatically switchover should a failure occur, as directed by a monitor and control system.

In a preferred version of the present invention, an inbound data channel enables either the headend to receive responses to inquiries from the exhibitor, such as for playback information, security status, or theater module performance status. The headend also can receive confirmation of inputted data such as authorizations, entitlement modifications, or financial or administrative messages. Additionally, the exhibitor can use the data link to make inquiries of all kinds, update information, provide statistical information, and to pay for services electronically. The inbound data lines provide the headend with the ability to receive data and messages from not only the exhibitors, but also the studios, suppliers, financial institutions, and other entities which need technical and/or administrative data interfaces with the headend.

Another inbound channel may be provided for reception of cinema files from a Creator/Editor's System (described below), which allows authorized viewing and editing of cinema files by creators and editors. The Creator/Editor's System includes subsystems which provide capability for editing and baseband processing of cinema files at remote locations, and allows transmission of cinema files back to the headend. After cinema files are received by the Headend System from the Creator/Editor's System, they are generally stored in a Long-Term Archiving Storage System.

Sensitive data sent to the headend may be encrypted so that encrypted data, as well as data which has not been encrypted, can be routed to its destination address, acknowledged if applicable, and stored if appropriate. An internal router is used to forward data to applicable outbound transmission lines as required. The routing of technical and administrative data is accomplished via a local area network (LAN) with appropriate security safeguards, such as multi-level passwords and firewalls to prevent unauthorized access.

3. Management of Cinema Files and Databases

Access to the electronic cinema program files is controlled by a Conditional Access System (CAS) for the following reasons:

1. To ensure that only authorized playback of the files occurs.
2. To ensure that the terms and conditions of the contracts between distributor, service provider, and exhibitor are enforced.
3. To ensure that the revenues derived from the playback of the files are retrieved for the distributor and the service provider.
4. To prevent piracy of the files.
5. To ensure that the files in storage media cannot be accessed without authorization and accountability.
6. To ensure that any other sensitive data or files cannot be accessed, or altered, without authorization and accountability.

The CAS manages the flow of entitlements (authorization information), and other information such as motion picture, audio, and data bit streams to their destinations (for example, the theater receiver-decoder, storage, and playback systems, the archiving storage systems, and through the encryptors and decryptors). Entitlements originate in the Distribution Management System (DMS), which contains a database on all the deal memos between distributors, service providers, exhibitors, and other subscribers, and contract information on any other services including any conditional access requirements. The CAS also provides a very high level of both physical and electronic system security to regulate the viewing of files at the destination, and to eliminate the ability of pirates to intercept files and view their contents.

The CAS comprises four subsystem which provide control, security, and distribution of cinema and data files. These subsystems are:

1. Entitlement Management Center (EMC): receives the exhibitor/subscriber data and cinema/data file access data (CAD) from the DMS. The EMC constructs Entitlement Management Messages (ENM from this received data.
2. Entitlement Controller (EC): generates the following data packets which provide entitlement instructions:
   (a) An Entitlement Control Message (ECM) is created by combining the cinema/data file access data with an authentication signature;
   (b) An authorizing key (Control Word) is also created for each cinema/data file, and delivered to the encryptor. The Control Word governs how the file will be encrypted and later decrypted at the receiver-decoder. It is not broadcast to the receiver decoder.
   (c) In addition to creating the above data packets, the EC forwards the EMM to the receiver-decoder.
3. Conditional Access Module (CAM): resides in the receiver-decoder, and controls access to the incoming files. This module may, for example, consist of an ISO Smart Card reader and a Smart card. The Smart Card reader manages the exchange of information between the Smart Card and the receiver-decoder. Upon receipt of an entitlement message, the Smart Card reader verifies that the entitlement message is authentic, and then compares the entitlement data in the received

message with the entitlement data resident in the Smart Card. If they match, the appropriate Control Word is generated to be used by the decryptor to unscramble the cinema/data file.

4. Callback capability: also may be provided to allow the receiver-decoder to call the EMC, or the EMC to call the receiver-decoder. The EMC can receive data back from the exhibitor/subscriber Smart Card. This data includes exhibitor/subscriber identification, stored transactional information such as number of playbacks, and equipment status reports. The EMC may also call the receiver-decoder to deliver new data to the Smart Card.

A Distribution Management System (DMS) manages the distribution of the cinema and data files, and the flow of traffic and timely operation of the various subsystems of the headend and the theater systems. Its major tasks include:

1. Keeping a current and historical record of studio distributors, independent studios, independent distributors, and exhibitors.
2. Keeping a record of deal memos, including a breakdown of all contract requirements imposed on the service provider and the exhibitor.
3. Providing a Billing System which will provide financial analysis and statements related to the financial terms of the individual deal memos.
4. Generating conditional access information which is delivered to the CAS for further processing into Entitlement Management Messages, which are used to enable the decryptor in the receiver-decoder.
5. Enabling the release of files from the Long Term Archiving Storage System, including providing authorization information to the CAS, and providing instructions to the Long Term Archiving Storage System to playback files, or portions thereof.
6. Providing a Traffic/Scheduling System which provides scheduling information to all Headend and Theater subsystems which must conduct timed operations. This system also receives feedback from the Theater systems, for example, as played information, requests to reschedule playback, and other requests which require initiating new entitlement messages.
7. Providing an Automation System which receives the traffic/scheduling information and then actuates the operational equipment as scheduled. Upon initiation and completion of these tasks, the Automation System provides timely reports back to the DMS.
8. Providing a Customer Service organization which provides a customer-friendly interface, particularly for assistance of customers with trouble-shooting problems and resolution of customer complaints.
9. Providing interactive data exchange between the DMS and the other software systems.

The DMS contains sensitive data which must be protected from unauthorized access. Therefore, the system includes multi-level password protection, firewalls at data I/O ports, and sufficient redundancy of the hardware to prevent loss of records.

A Cinema File Management System (CFMS) provides a database of all the cinema files in the Headend, and at Theater locations. A database record is created for each cinema file, with a separate record for each motion picture image, audio, and associated data file. The record is expanded and updated each time a cinema file is processed at the headend to include its status, location, copies if any, type of processed file, and modifications. A separate database is kept of all cinema files which are placed in the Long-Term Archiving Storage System. This database includes historical information on who, why, when, and what was accessed, and the authorization information. The CFMS also keeps individual records of cinema files stored in the Theater storage systems and the purging thereof. The CFMS provides status reports on a routine basis, and exception reports on an urgent basis when certain operations, such as purging, fail to occur as scheduled. These reports are provided to the DMS.

A Data File Management System (DFMS) serves a function equivalent to that of the CFMS, except the files which are managed are non-cinema files. These files could include data such as program associated files, data describing a particular cinema, its production, and other historical data concerning a cinema file which might interest an exhibitor or the cinema audience. The data could include subtitles, teletext, special interest information, and a myriad of other possible data transfers between the service provider, distributor, and exhibitor. In some cases the data is encrypted, in other cases it is not. The DFMS keeps records of all the data files, their location, and historical information on the processing, access and disposition of the data files.

A Web Page Management System (WPMS) provides an up-to-date web page, which can be accessed via the Internet by external users with authority to view a file stored in the Long-Term Archiving Storage System. The files stored in the archive are encrypted and therefore security arrangements are highly stringent. The WPMS provides the user with the ability to do a data base search to identify a file of interest, and obtain a brief abstract and other program associated data. The WPMS provides authorization to users to allow viewing of files with proper security safeguards. For example, an editor could be sent an encrypted copy of the file, which could be read by the editor's personal receiver-decoder upon authorization by the CAS. In this example, the DMS would provide the user entitlement message to the CAS. The WPMS also provides administrative messages to Customers and Vendors, and provides public relations messages to all other interested parties.

B. Theater System

1. Transmission Line Interfaces

Cinema and data files can be delivered by a satellite communication link, or terrestrial communication links such as microwave, coaxial cable, or fiberoptic cable. If, for example, a satellite transmission medium is used, the earth station transmission system may comprise a downconverter, an interfacility link (between the downconverter and the demodulator/tuner), and a downlink antenna.

In a preferred version of the present invention, a Ku band link is utilized with a small antenna (dish) mounted on the roof of theaters. The dish size is a function of the desired reliability of the transmission link from the headend to the theater. For example, for programs which are delivered only for storage on the theater storage system, link outage probability of three hours a month may be reasonable. However, for real-time transmission and presentation, a link outage during a performance would be unacceptable, and thus it would be more acceptable to have a probability of an outage of less than 30 minutes during a month. In general, dish size is in the range of 1.0 meter to 2.4 meters in diameter.

The received signal of such a link is collected by the antenna and forwarded to a low noise downconverter which converts the Ku band signal to a signal in the 950 to 1450 MHz band. The low noise downconverter has sufficient gain to allow an interfacility link coaxial cable to be run from the

antenna location to the indoor demodulator/tuner of the indoor receiver-decoder.

An outbound data channel (reverse channel) is provided so that two-way data communications can be established between the headend and the theater system. An outbound channel can be used for many purposes including sending inquiries, playback information, security status, theater module performance, confirmations, electronic payments, and e-mail. Data packets within the bit stream of an outbound data channel may be encrypted in accordance with instructions from the CAS.

The outbound data channel can utilize satellite or terrestrial transmission media. If, for example, satellite transmission is utilized, then a low power uplink transmitter is provided. This uplink transmitter is interfaced to a transmit port of the antenna. In a preferred version, the uplink transmitter includes a medium power amplifier (0.5 to 2.0 watts), an upconverter from the frequency band 950 to 450 MHz to the satellite receive transponder frequency, and a modulator/tuner which receives outbound (reverse) data from the theater system and provides a radio frequency carrier, which is chosen to provide the authorized satellite transponder frequency after upconversion by the upconverter module (which follows the tuner). The carrier output frequency is electronically programmable, and is assigned by the broadcast operations module of the DMS.

2. Receiver-Decoder

A receiver-decoder comprises a tuner/demodulator, a system demultiplexor, microprocessor/controller, and a Conditional Access Module (CAM).

In a system utilizing satellite transmission, for example, transmission may be at 96 Mbps with 16PSK modulation and a ¾ rate trellis code. This provides a net of three bits per symbol at a symbol rate of 24 megasymbols per second, and a coding gain of 6.6 dB. Other channel coding techniques, well-known to those skilled in the art, can be used in the present invention.

In a preferred version of the receiver-decoder operating in L band, a L band tuner of the Tuner/Demodulator is tuned to a specific L band frequency associated with a specific downlink satellite transponder. The output of the tuner is demodulated to a baseband digital bit stream, and then the FEC is removed. The resultant bit stream is an encrypted, multiplexed bit stream containing audio, motion picture image, and data information.

A system demultiplexor then separates the bit stream into its audio, motion picture image, and data bit streams. The resultant bit streams are then forwarded to the appropriate ports or interfaces under direction of a microprocessor/controller.

A microprocessor/controller provides instructions which direct the activities of all the I/O ports, and does all the housekeeping tasks necessary to provide a functioning receiver-decoder. It may also compare a user profile stored in receiver-decoder memory with an incoming data message describing a specific user profile, and either accept or reject the incoming bit stream. If the incoming bit stream is accepted as valid for a particular receiver-decoder, then entitlement information is passed to the Conditional Access Module for further processing. In addition, the microprocessor/controller accesses the receiver-decoder memory which may contain instructions and messages such as error messages. These messages can be displayed locally or forwarded to the headend via the reverse channel.

A CAM receives EMM and ECM data from the headend, verifies the authenticity of the data, compares the data with stored information, for example, in a Smart Card, and, if validity is established, generates a key word necessary to enable the decryptor. In a preferred version of the present invention, the key word is generated on a packet by packet basis. In this case, each location which has an encryptor and/or a decryptor has an associated receiver-decoder and a CAM. These locations include the Secure Projector System, the Speaker System, and the User Data Channel. The key word is transferred to the encryptor/decryptor in a secure environment. For example, removal of the Smart Card or the CAM from the receiver-decoder disables the receiver-decoder.

3. Storace Playback System

Each current authorized movie is stored in compressed and encrypted form in a storage media. In a preferred version of the present invention, ganged rewritable non-removable Raid hard drives are used. Other storage media, well-known to those skilled in the art, can be used in the present invention. The selection of the storage media is predicated not only on capacity, redundancy, I/O ports, access time, throughput, and file transfer rate, but also on the security needs of the system.

For example, the storage media may have over 150 gigabytes of storage that can playback at a data rate of at least 8 megabytes per second. For theaters with multiple screens, the storage media is sized to provide storage for all cinema files.

An automation system (described below) delivers each cinema file to a secure projector system at a time specified and authorized by the CAS. Since movies are often transferred to different screens within a given theater based upon audience size, the DMS manages such transfers upon verification and authorization by local theater-generated instructions. When a particular cinema file is projected for the last time, the storage media is automatically erased and another authorized cinema file is stored in its place.

4. Secure Projector System

The secure projector system comprises the following subsystems:

1. demultiplexor (demux)/motion picture image decryptor;
2. output port to forward encrypted audio to an audio distribution controller;
3. motion picture image decompressor;
4. visual projector; and
5. interface with a CAM (there may be a separate CAM for each subsystem that either encrypts, decrypts, stores, or forwards encrypted or entitlement data).

In a preferred version, the projector system is designed so that decryption of the motion picture image takes place within the projector with sufficient security to prevent interception of the decrypted motion picture image file. It is a sealed assembly which if opened not only causes the loss of the stored cinema file, but also makes the projector inoperable until serviced by an authorized field service technician.

The Demux/Motion Picture Decryptor receives encrypted files from local storage, separates motion picture image, audio, and data files into separate bit streams, then decrypts them and provides the outputs to the data, audio and motion picture image decompression units.

Separate motion picture image and audio decompression units are employed. In such systems, each decompression unit has sufficient programmability so that a variant of ISOMPEG2 coding technology can be used at present, while allowing decompression units to be upgraded to ISOMPEG4 and beyond in the future. The ISOMPEG2 System transport layer may be employed to ensure that appropriate synchronization is maintained between the audio and the motion picture image.

Advanced Audio Coding(AAC), ISOMPEG4 Part 7, which currently provides the most efficient 5.1 channel audio available, may be used as an audio coding algorithm, although any other audio coding algorithms can be accommodated. It is anticipated that in many theaters, more than five channels of audio will be required, requiring multiple channels of AAC in multichannel or stereo configurations. Other motion picture and audio coding algorithms, well-known to those skilled in the art, can be used in the present invention.

The projector is preferably designed to meet high quality projection requirements for exhibition of 35 mm (or other) films. These requirements may include display of approximately 8 million pixels for each of 24 frames per second, brightness for a 70 foot diagonal screen (approximately 6,000 lumens), and provisions to discourage camcorder piracy. A projector technology which can meet these requirements is liquid crystal-based Image Light Amplifiers (ILA). Other projection technologies, such as Digital Mirror Devices (DMD), well-known to those skilled in the art, can be used in the present invention. To achieve the feel of film, the images are displayed one frame at a time (as opposed to video which writes one pixel at a time sequentially). A two stage ILA device may be used. The output stage is similar to existing ILA devices that can produce brightness levels of over 6,000 lumens. In a preferred version, the writing stage of the ILA utilizes transmissive LCD panels which provide the writing function. Thin, single crystal LCD tiles typically are used. By way of example, these are available in 1080 by 1920 pixels format. As is shown in FIG. **3**, four of these tiles can be used to provide a resolution of 2160 by 3840 pixels.

In this example, four LCD tiles are imaged onto the output stage of the ILA, which serves as an optical low pass filter that eliminates seams between the tiles in the output or observation space. Thus, no cracks are visible to the observer. An embodiment of such tiling technology is described in D. Mead, U.S. Pat. No. 5,555,035, incorporated by reference herein. Transmnissive LCDs are preferably backlit by a light source which is optically filtered to create the correct wavelengths for the ILA photoconductive layer. Image data is read into the LCDs before they are illuminated by the light source. The frame rate of the projector can be varied pseudorandomly to inhibit camcorder piracy. This is described in D. Mead, U.S. Pat. No. 5,680,454, incorporated by reference herein. Other projector technologies, well-known to those skilled in the art, can be used in the present invention.

A receiver-decoder and an associated CAM may be provided within theaters at each location where decryption takes place (the Secure Projection System, the Speaker Systems, and the User Data System). The receiver-decoder forwards entitlement messages which are particular to each CAM, which then generates the key word necessary for decryption.

5. Other Theater Elements

In theaters, the screen is the display for the cinema. The size, aspect ratio, and the reflectivity of the screen must conform with the projector output characteristics to provide an acceptable theater presentation. Screen specification standards are established to provide assurance of reasonable quality control.

An Audio Distribution Controller of a preferred version of the present invention provides an encrypted digital output which is transmitted to each speaker system. Other audio distribution technologies, well-known to those skilled in the art, can be used in the present invention.

The transmitted encrypted audio signal is received by the speakers in the theater. The speakers are physically mounted to provide a direct line of sight from the secure projector system to the speaker systems. In the theater audio system, each speaker system has an internal speaker, a receiver-decoder, a CAM, a decryptor, and an audio decompression unit which are physically secure to prevent piracy. The decryptor only decodes audio packets directed to its associated speaker.

6. Automation/Schedulina System

Within the bit stream provided by the Headend to a specific theater is a playback schedule. This schedule defines the authorized playback times for each cinema file and for each screen in the theater. The automation/scheduling system schedules these playbacks, and provides the necessary machine control to automatically play the cinemas at the scheduled times. It includes the scheduling and playout of all trailers.

A theater operator interface provides the operator with the ability to modify the schedule, such as changing play times, and which screens are showing which cinemas. Such changes require notification of the headend. Changes which do not violate contractual terms are automatic, requiring only a change in the distribution records. Changes which modify the terms of an existing contract between Exhibitor, Distributor, and Service Provider are verified and authorized by the DMS once accepted by the parties to the contract. This interface also may provide a facility for allowing theater operators to insert locally-generated materials such as advertisements for local businesses.

7. Reverse Channel

A reverse channel provides data back to the headend and the studio distributor from the theater. The data includes status information, as played information (actual times of playback), purges (erasure of cinema files), trouble reports and error messages, diagnostic information, and other messages related to the health and welfare of the theater system. The reverse channel also may be used for administrative and financial information. Since the reverse channel provides the theater with a two-way data capability (utilizing the forward data transmission capability of headend transmission system), interactive data applications can be utilized to provide interactive experiences to theater audiences.

C. Creator/Editor's System

The creative process involved in producing a cinema is a collaborative process between creators, editors and film processors. Once the original camera negative is converted to a lossless digital file, editing and review is simplified by utilizing powerful computer editing systems. As a result, creators and editors require access to the long term archival storage system so that they can retrieve specific files, perform editing and review functions, and then place an authorized amended version of the cinema file back in storage. Thus, a system must be provided to allow authorized viewing and editing of a cinema file by creators and editors. The requirement for this system adds additional security and distribution management requirements to the overall system architecture.

As is shown in FIG. **4**, many of the subsystems in the Creator/Editor's System are similar to those of the Theater System. The Creator/Editor's System comprises the following subsystems:

1. Transmission Line Interface
2. Tuner/Demodulator
3. Receiver-Decoder comprising a System Demux, a Microcomputer, Local Memory, a User Profile, a Reverse Channel.

4. User Storage/Playback System
5. Reverse Channel Transmission Line Interface.
6. Demux/Motion Picture Decryptor
7. Motion Picture Decompressor
8. Audio Distribution/Decryptor
9. Conditional Access Module
10. Interface with Editor's Workstation
11. Motion Picture Compressor
12. Multiplex/Encryptor
13. Modulator-Tuner
14. Editor's Cinema File Management System, including interfaces with Headend CFMS

Only the subsystems which are significantly different from those of the Theater System are described in this Section. In particular, the following subsystems are described below: User Storage/Playback System, Motion Picture Decompressor, Interface with Editor's Workstation, Motion Picture Compressor, and Editor's Cinema File Management System.

At the headend, a cinema file is retrieved from the long term archiving storage system, upon authorization by the CAS, to forward that specific file to a particular Creator/Editor's System. An encrypted cinema file is then transferred from the Headend System to the Creator/Editor's System via a transmission medium. The encrypted cinema file may be compressed utilizing either lossless or lossy compression technology as described previously. In addition, the audio file may be transferred uncompressed. The Storage/Playback System of the Creator/Editor's System receives the encrypted cinema file and stores the file. The cinema file may require up to 1.0 terabyte of storage for each hour of storage capacity, since the file may be delivered with lossless compression. The Storage/Playback System provides the ability to forward all or portions of a stored cinema file to the Editor's Workstation. In addition, the user can insert or replace specific portions of a cinema file utilizing the Editor's Cinema File Management System (ECFMS) (described below).

After the cinema file is retrieved from the Storage/Playback System and decrypted, it is decompressed. The decompressor recognizes whether the file is a lossless or lossy compressed file, and decompresses the file accordingly. The resultant output bitstream represents a motion picture with resolution of eight to twelve million pixel per frame.

A cinema file may be transferred to and from an Editor's Workstation under the direction of the Editor's Cinema File Management System. A transfer is made only after all security checks and authorizations are validated. The Editor's Workstation provides the ability to view the motion picture at full, or reduced resolution, and to make authorized modifications in the motion picture file. It may also provide the ability to review and edit the uncompressed audio file of the cinema.

When the work of the Editor is completed, and the edited file is to be returned to the Long-Term Archiving Storage System, then the replacement cinema file must be transferred to the headend under the direction of the Cinema File Management System of the headend. In a preferred version of the present invention, a replacement cinema file is compressed in the Creator/Editor's System using the lossless compression technology described previously. Cinema files may be transferred between Creator's and Editor's Systems which are not physically located in the same place. These transfers may be made utilizing the lossy compression technology described previously. Thus, for example, the compressor may have the ability to provide lossless or lossy compression as directed by the ECFMS.

The ECFMS provides a database of all the cinema files at a Creator/Editor's System location. A data base record is created for each cinema file, with a separate record for each motion picture, audio, and associated data file of the cinema. The record is expanded and updated each time the cinema file is processed in the Creator/Editor's System to include its status, location, copies if any, type of processed file, and modifications. The ECFMS provides status reports, requests for entitlements, and requests for file transfer to the CFMS. The CFMS schedules the transfer of cinema files, or portions thereof between the User Storage/Playback System and the Editor's Work Station. It may also schedule the transfer of cinema files or portions thereof between Creator/Editor's Systems. In addition, the ECFMS provides instructions to the Automation System of the Creator/Editor's System to activate machine control of subsystems, for example disk drives, on schedule.

A separate data base is kept of all cinema files which are removed or placed in the Long-Term Archiving Storage System. This data base includes historical information on who, why, when, and what was accessed, and the authorization information.

The ECFMS also keeps individual records of the Cinema files stored in the Creator/Editor's storage systems and the purging thereof. The ECFMS provides status reports on a routine basis, and exception reports on an urgent basis when certain operations, such as purging, fail to occur as scheduled. These reports are provided to the DMS.

Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

In the following claims, those claims which do not contain the words "means for" are not intended to be interpreted in accordance with 35 U.S.C. section 112, paragraph 6.

What is claimed is:

1. A system for delivery of digital electronic cinema to a plurality of users including theaters, comprising:

a headend system comprising a baseband processing system which receives analog cinema film as input, a storage system which receives digitized cinema files from the baseband processing system, a radio frequency transmission system which communicates cinema and data files to various users including theaters as radio frequency bit stream, and which further communicates data from said users, and a management system which controls transmission and storage of cinema and data files;

a theater system comprising transmission line interfaces at theaters designated to receive cinema and data files from the headend system, receiver-decoders which receive the radio frequency bit stream and produce decoded cinema and data files at baseband, a storage playback system which stores cinema and data files until needed, and a secure projector including a decryptor for playing back encrypted cinema files;

an editor's system which allows authorized viewing and editing of cinema files, wherein the editor's system provides capability for editing and baseband processing of cinema files at remote locations, and transmits edited cinema files back to the headend system.

2. The system of claim 1, wherein the editor's system comprises a second receiver-decoder which decompresses

motion picture image files which were compressed using lossless or lossy compression algorithms, a high capacity storage playback system, and a workstation for reviewing and editing cinema files received from the headend system.

3. The system of claim 1, wherein the editor's system transmits edited cinema files back to the headend system utilizing a subsystem comprising a baseband processing system, a modulator/tuner, and a satellite uplink transmission system.

4. The system of claim 1, wherein edited cinema files transmitted by the editor's system are received by a headend subsystem comprising a satellite downlink system, a demodulator, a receiver-decoder, and stored in the storage archiving system.

5. A method for delivers of digital electronic cinema, comprising the steps of:

transferring a motion picture image to a digital signal in a digital format which is of substantially the same visual quality as the motion picture image in its original form; and

transmitting the cinema in the digital format, wherein the cinema is received by a plurality of end users according to a security scheme, and the step of transmitting the cinema includes allowing authorized viewing and editing of cinema files by creators and editors at remote business locations.

* * * * *

US005959717A

United States Patent [19]

Chaum

[11] Patent Number: 5,959,717

[45] Date of Patent: Sep. 28, 1999

[54] MOTION PICTURE COPY PREVENTION, MONITORING, AND INTERACTIVITY SYSTEM

[76] Inventor: Jerry Chaum, 14652 Sutton St., Sherman Oaks, Calif. 91403

[21] Appl. No.: 08/989,737

[22] Filed: Dec. 12, 1997

[51] Int. Cl.[6] G03B 21/32

[52] U.S. Cl. 352/40; 352/55; 352/90; 352/133

[58] Field of Search 352/38, 40, 41, 352/55, 90, 133

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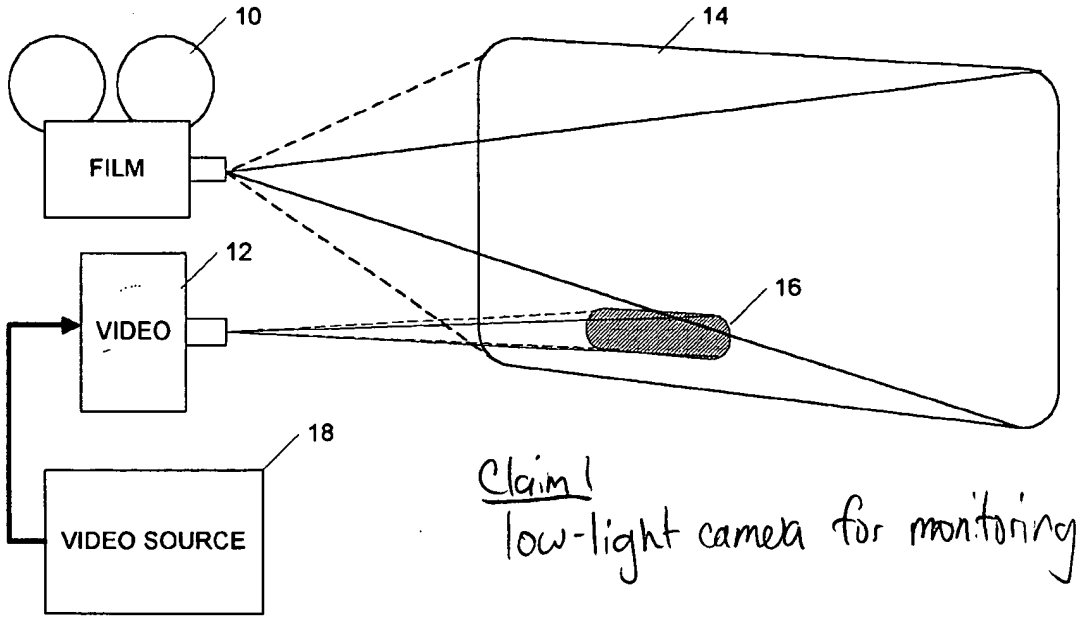
Primary Examiner—Russell Adams
Attorney, Agent, or Firm—Fish & Richardson P.C.

[57] ABSTRACT

A combination film projector and video projector for showing a single composite motion picture, and a motion picture audience monitoring system. The video projector is used to provide image content for a video display subarea on the projected film image. Thus, all of the light output of the video projector is focused on a substantially smaller subarea of the screen. Uses of the combination of both a film projector and video projector include theft deterrence and special effects. Another aspect includes a motion picture audience monitoring system including a camera and/or microphone directed at the audience and coupled to an analysis system. The audience monitoring system can be used to obtain demographic information about the attending audience. The system can be used in conjunction with a pattern recognition system to determine such information. The output of the analysis system may be used in conjunction with the video source to provide a feedback system coupled to the film projector or video projector to alter the motion picture content in response to such feedback. Another aspect includes using a camera or microphone to provide a signal to the video source from which a synchronization signal can be derived. An alternative function for the camera would be to capture the projected image and provide a feedback video signal sufficient to measure characteristics of the projected image and adjust the output of the video projector accordingly.

16 Claims, 6 Drawing Sheets



Claim 1
low-light camera for monitoring

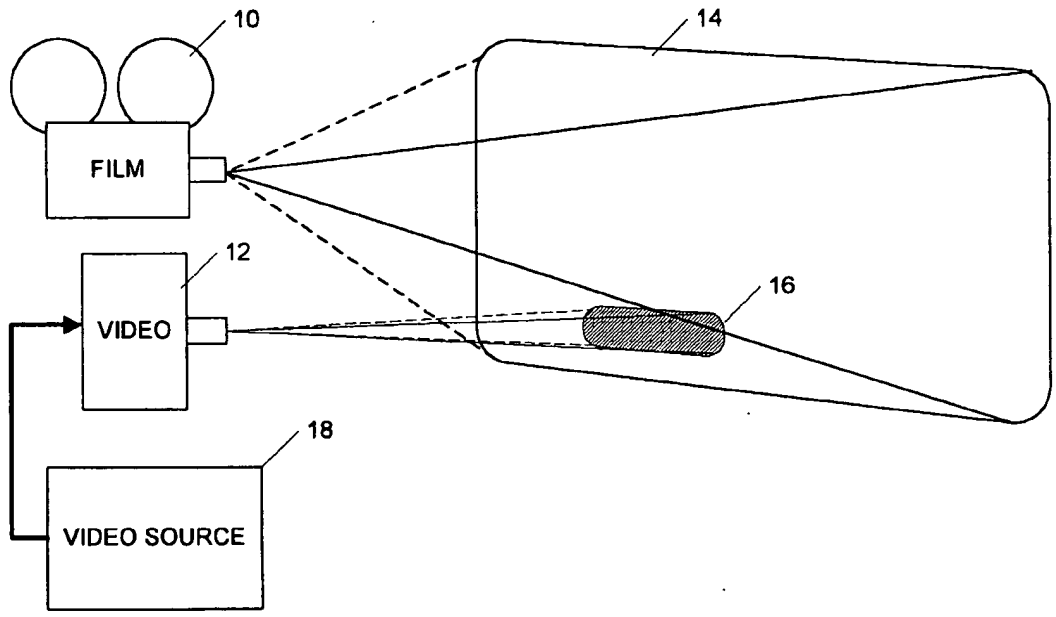


FIG. 1

FIG. 2A

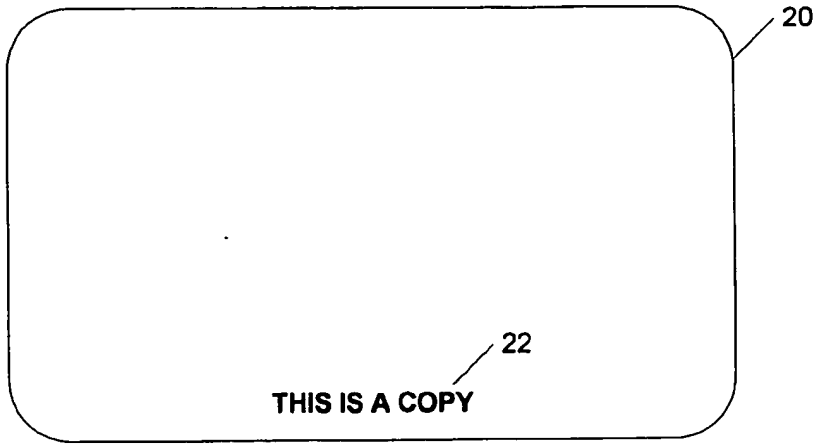


FIG. 2B

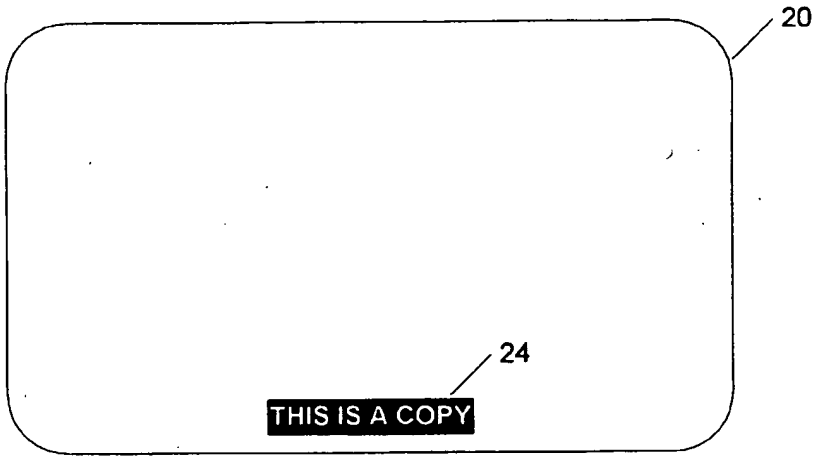
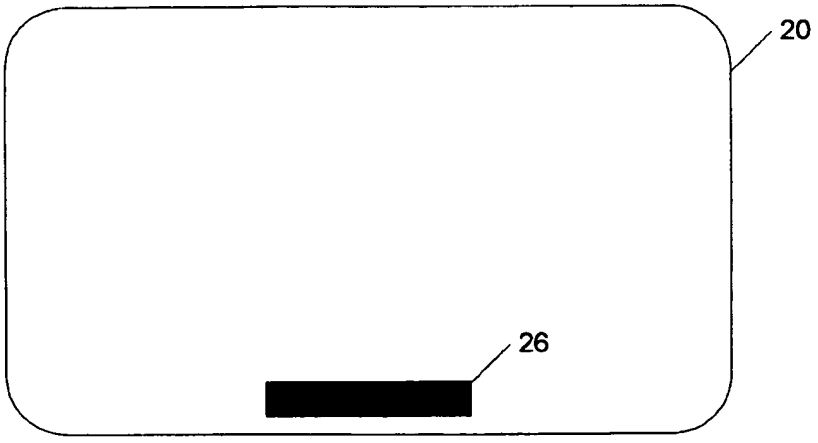


FIG. 2C



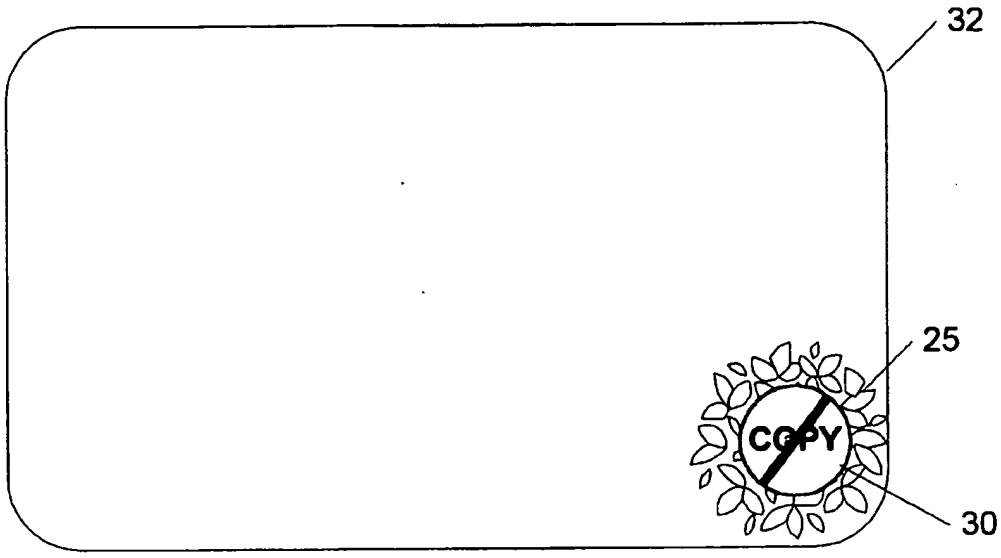


FIG. 2D

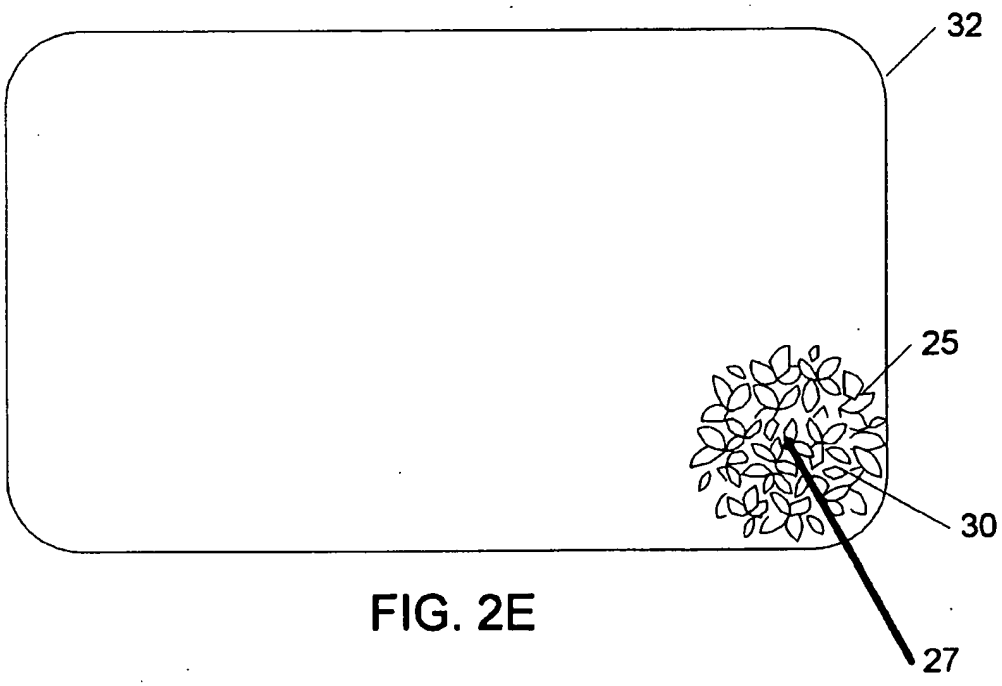


FIG. 2E

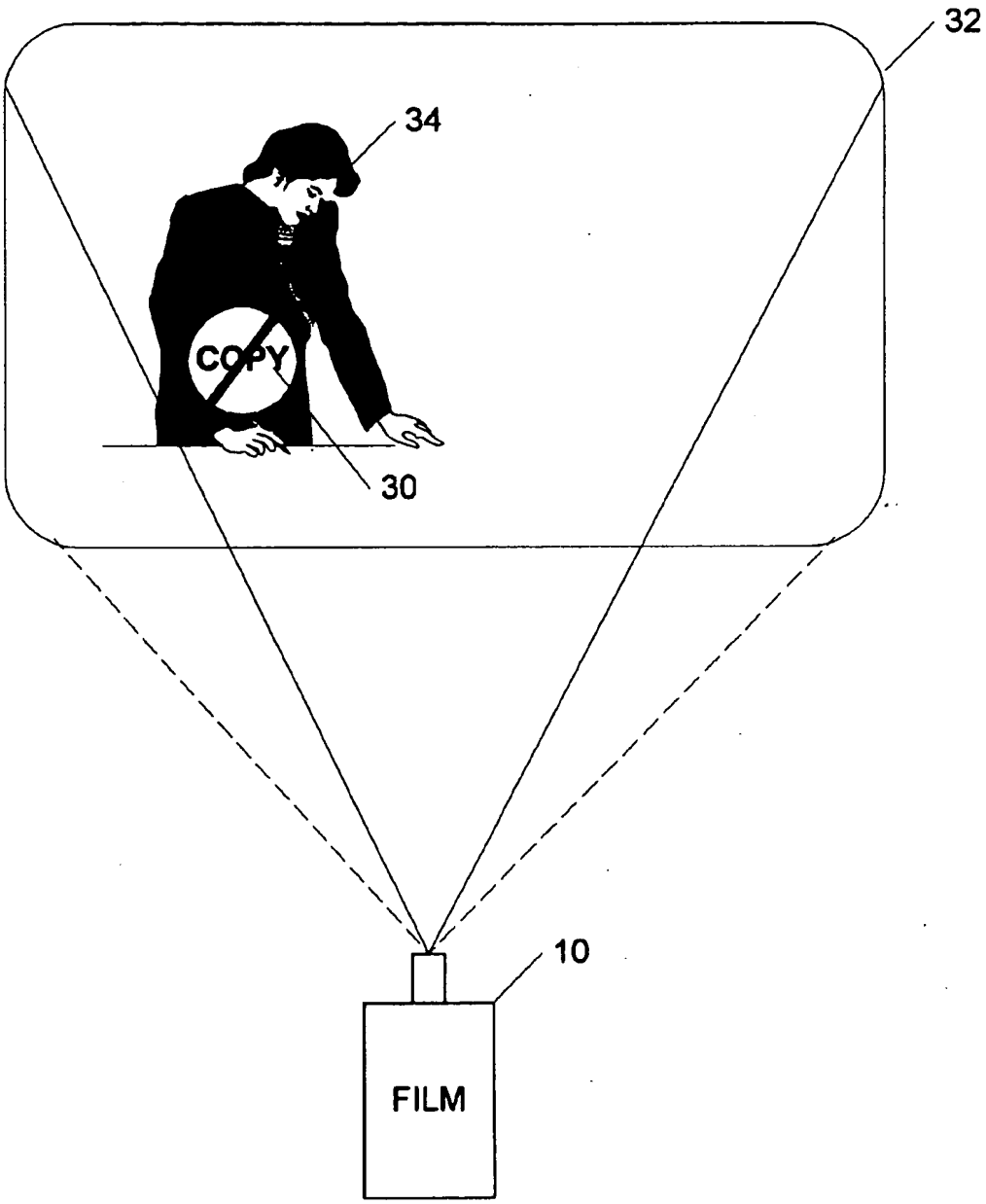


FIG. 3A

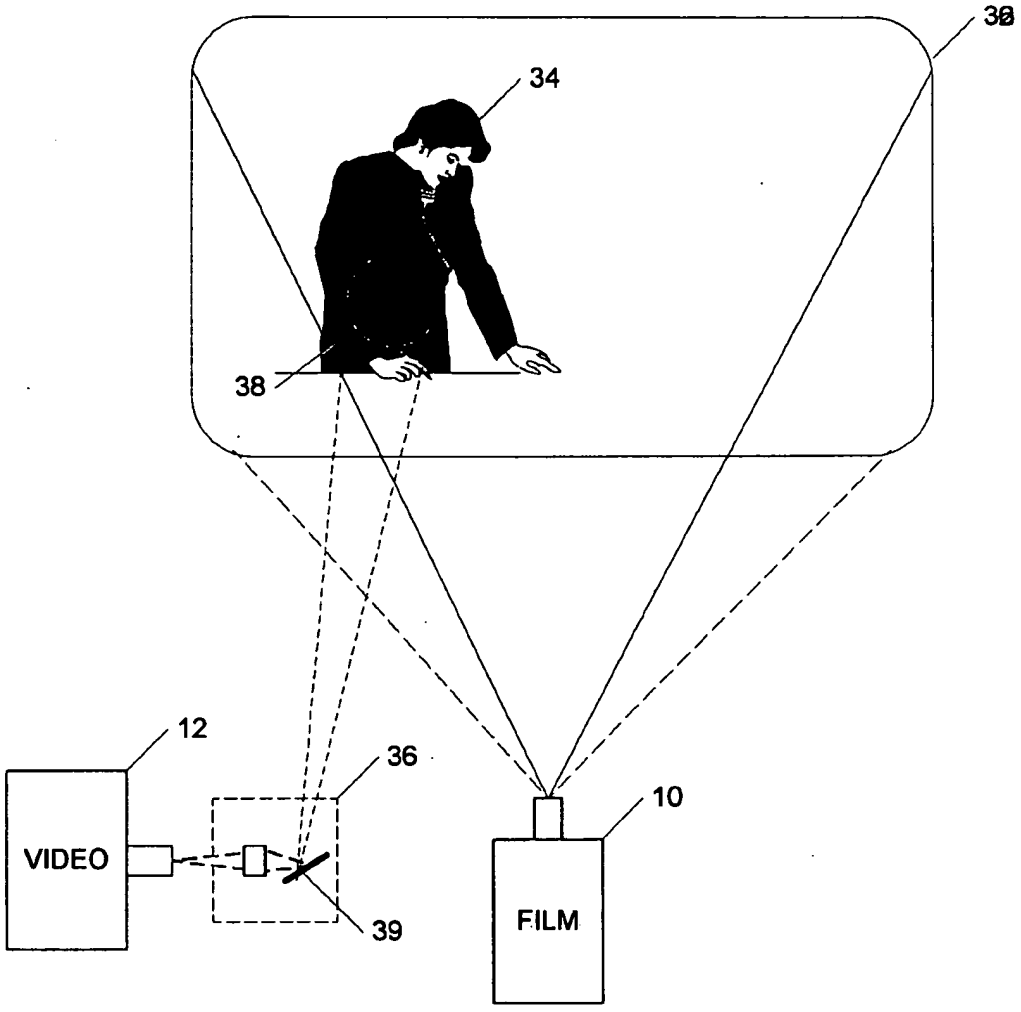


FIG. 3B

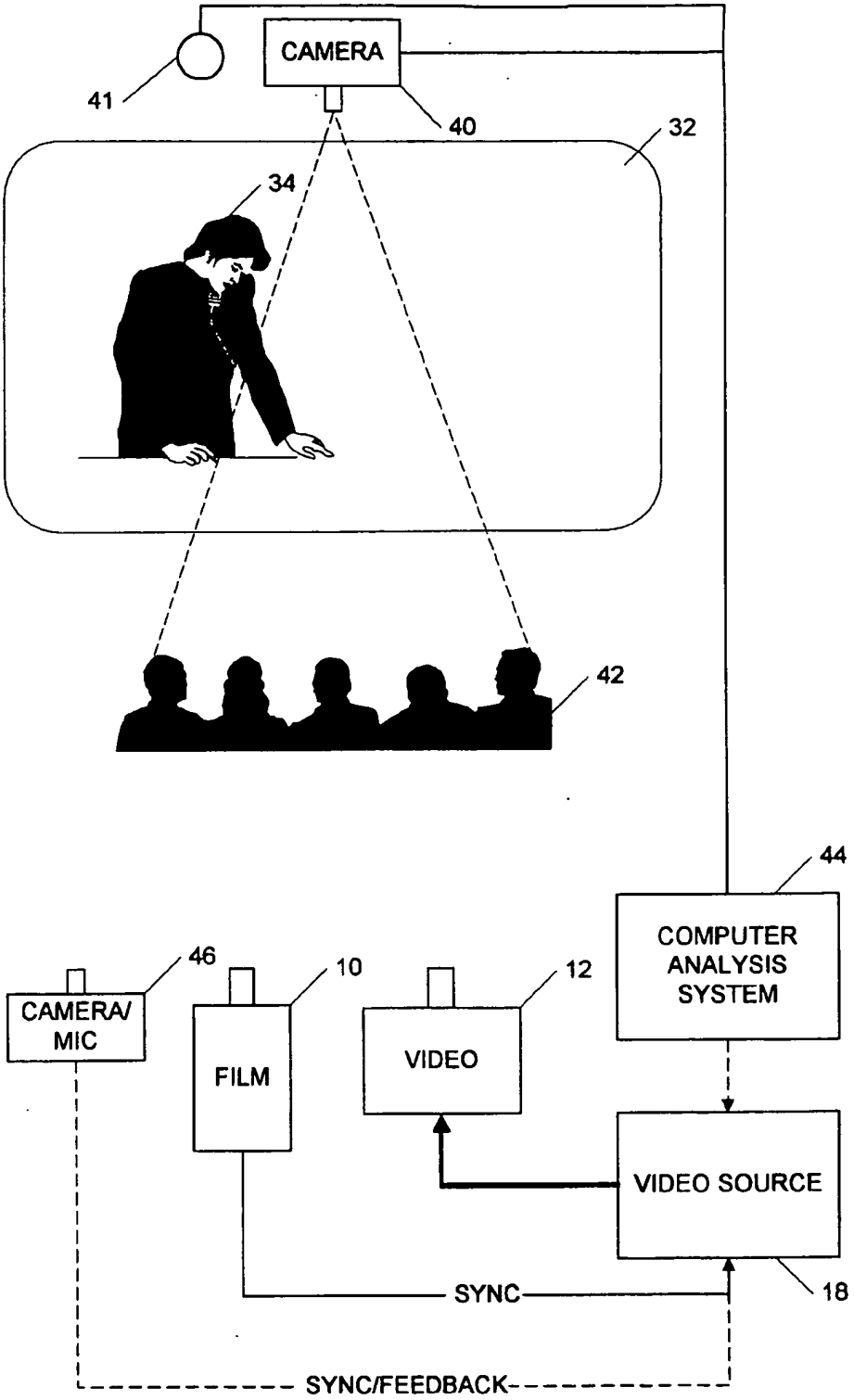

CAMERA
41
40
32
34
42
44
COMPUTER ANALYSIS SYSTEM
46
CAMERA/ MIC
10
FILM
12
VIDEO
VIDEO SOURCE
18
SYNC
SYNC/FEEDBACK

FIG. 4

MOTION PICTURE COPY PREVENTION, MONITORING, AND INTERACTIVITY SYSTEM

TECHNICAL FIELD

This invention relates to film and electronic projection of images, and more particularly to a combination of film and video projection systems.

BACKGROUND INFORMATION

Public screenings of motion pictures have long been dominated by film projection systems. Despite the advancement of electronic video projection systems, such as LCD-based video projectors, it appears likely that film projection of motion pictures will continue to be popular for some time. Film projection provides high brightness, high contrast, and high resolution projection of motion pictures, while present digital systems generally are deficient in these characteristics. Accordingly, it is believed that film will continue to appeal to film purists in the industry and to film-loving audiences. Further, there has been a huge investment in current technology, and an enormous investment would be required to change to non-film technology.

A problem in the motion picture industry is film piracy, which may be of several sorts. One form of piracy is the theft of motion picture film in order to create video tape copies for sale on worldwide black markets. A second form of piracy involves surreptitiously imaging a projected motion picture at a public theater using a video camera, in order to produce low quality copies of current release films for video tape black markets.

Other problems facing the motion picture theater industry are lack of adequate methods of determining audience demographics (e.g., audience counts, age distribution, sex distribution, eating and sitting habits, etc.), and the need to create interactivity and special effects to enhance competitiveness with home entertainment.

The inventors have determined that it would be desirable to solve these problems in an economical fashion that provides additional side benefits. The present invention provides a solution to these problems in just such a fashion.

SUMMARY

One aspect of the invention includes a combination film projector and video projector for showing a single composite motion picture. The video projector is coupled to a video source. The video projector is used to provide image content for a video display subarea on the projected film image. The video projector need not have sufficient illumination power, contrast, and resolution to provide an acceptable projected image of a motion picture that fills an entire screen. Rather, all of the light output of the video projector is focused on a substantially smaller subarea of the screen. Uses of the combination of both a film projector and video projector include theft deterrence due to difficulties of copying, and special effects due to the dynamics and interactivity of digital media.

For theft deterrence, a motion picture may be provided in two parts—a film component and a video component. The film component may have a selected portion—a "protection area"—of selected frames omitted. Conversely, the video projector is provided with a video signal that provides image content for the protection area omitted from the film version of the motion picture. Copy protection is improved because a thief would have to steal both components in order to display a complete motion picture. Pirated copies of the film would have "holes" in the video content unless the thieves managed to also steal and use the video component of the motion picture. In an alternative embodiment, the two parts may comprise first and second video components. Other theft deterrence aspects of the invention include the following:

- The protection area may include an alert message or symbol that is camouflaged by the output of the video projector. For example, "positive" or "negative" images can be "punched out" from a full color film image, and the missing image information supplied by the video component (either concurrently or in rapid succession), so that when the composite image is "integrated" by the eye, the protection area becomes invisible on the screen, no matter where positioned. A video camera or media thief may have access to only some of the images and thus only a copy with the visible alert message.
- Theft of the video component can be made more difficult or impossible by shipping a video version separately from the film version of the motion picture.
- Theft of the video component can be made impossible by providing a video signal to a motion picture theater from a remote site through a telecommunications link.
- If a removable media is used to provide the content for the video projector, it may desirable to conform the video media so that it only works with a specific film copy of a motion picture.
- The video media may be erasable or alterable so that the video source can only play the video media a pre-set number of times.
- In all of the embodiments in which an alert message is used, the message may be a time and place "stamp" useful in attempting to track down in-theater video thieves by backtracking recovered pirated video tapes to a particular copying source. Alternatively, the alert messages can say things like "CALL XXX-XXXX FOR A REWARD", where the telephone number could be dynamic depending on the screening. A static message about copyright law enforcement could also be used, possibly customized by country.

For special effects, the combination of one of a film or video projector, plus a video projector, may be used to provide augmentations to conventional special effects or may vary the content of the motion picture. Special effects aspects of the invention include the following:

- A single film can have different ratings by adding film elements using the video projector.
- A film scene can be altered to provide different content, such as advertising or local language versions of text.
- Such special effects as the use of the video image to enhance the brightness, resolution, or speed of, for example, an animated character or "magic sparkle" that moves around the screen.

In another aspect, the invention includes a method and apparatus for displaying a composite image, including projecting a first image having at least one portion of the image altered to provide at least one protection area; and projecting separately a second image having image content to obscure each protection area; wherein the first image and second image form a composite image in which each protection area is essentially invisible to the human eye.

Another aspect of the invention includes a motion picture audience monitoring system. The output of a camera and/or microphone (with the movie soundtrack possibly electroni-

cally canceled) is coupled to an analysis system, the output of which is optionally coupled to the video source described above. The audience monitoring system can be used to obtain demographic information about the attending audience. The system can be used for "manned" monitoring, but is preferably used in conjunction with a pattern recognition system to determine a variety of factors about the audience. The output of the analysis system may be used in conjunction with the video source to provide a feedback system coupled to the film projector or video projector. Monitoring aspects of the invention include the following:

- If the analysis system can determine the attendance for the audience, that information can be recorded and/or provided to remote sites and/or provided to the video source and projected by the video projector some time before, during, or after the projection of a motion picture.
- The image taken by the camera may be re-projected through the video projector onto a screen so that, for example, the audience may see itself, a function that seems to be popular at sporting events. Alternatively, lottery-style choice of a person in the audience could be made, with the image of the selected person enlarged and projected.
- Demographic information obtained by the camera and analysis system can be used to alter the content displayed by the video projector. Thus, the video projector can be used to provide or augment images in order to provide variable plot or scene elements depending upon the characteristics of the audience.
- An authorization technology may be used with the audience monitoring system to positively allow a central site to authorize display of a complete motion picture based upon confirmation that the motion picture is being displayed at an authorized site before a legitimate audience. Such authorization may be done on a per screening basis.

Another aspect of the invention includes a feedback system using a camera or microphone or soundtrack sound and/or data output from a film projector to provide a signal to the video source from which a synchronization signal can be derived. An alternative function for the camera would be to capture the projected image on a screen and provide that image to a processor within the video source. The processor can use the video signal from the camera to measure the brightness, color balance, alignment, planarity, focus, etc. of the projected image and adjust the output of the video projector.

The details of the preferred embodiment of the invention are set forth in the accompanying drawings and the description below. Once the details of the invention are known, numerous additional innovations and changes will become obvious to one skilled in the art.

DESCRIPTION OF DRAWINGS

FIG. **1** is a block diagram showing a first preferred embodiment of the present invention.

FIGS. **2A–2E** are examples of an anti-theft marking system in accordance with the present invention.

FIGS. **3A** and **3B** are another example of an anti-theft motion picture projection system in accordance with the present invention.

FIG. **4** is a block diagram of a motion picture system and audience feedback system in accordance with other aspects of the present invention.

Like reference numbers in the various drawings indicate like elements.

DETAILED DESCRIPTION

Throughout this description, the preferred embodiments and examples shown should be considered as exemplars, rather than as limitations on the present invention.

FIG. **1** is a block diagram showing a first preferred embodiment of the present invention. One aspect of the invention includes a combination film projector **10** and video projector **12** for showing a single composite motion picture **14**. In particular, the video projector **12** is used to provide image content for a video display subarea **16** on the projected film image. As will be described in further detail below, the combination of both a film projector **10** and video projector **12** provides a number of benefits. In an alternative embodiment, the two projectors may comprise first and second video projectors. In an alternative embodiment, multiple projectors of the same or different technologies may be used.

The film projector **10** is conventional. It is contemplated that existing equipment used by motion picture theaters could be retained and used as part of the inventive combination. The video projector **12** is preferably of a high brightness, high contrast, high resolution type, and may be based, for instance, on the use of LCD, light-valve, digital mirror, CRT, laser, or functionally equivalent technology. The video projector **12** may have either an analog input (e.g., an input conforming to the NTSC television standard for the U.S., or the PAL television standard for Europe), or a digital input (e.g., for MPEG-II data streams). The video projector **12** is coupled to a video source **18**, such as a DVD video disk player or computer containing a DVD decoder, and may be local (i.e., situated at a specific motion picture theater site) or partly remote (e.g., coupled to the video projector **12** by means of a high speed communication link, such as a T1 or T3 telecommunications line, a video transmission cable, or a satellite link). The video projector **12** and the film projector **10** are synchronized. One synchronization technique is to optically or magnetically encode a timing track on the film media that is readable by a suitable transducer, in known fashion. Other synchronization techniques are described below. It desired, the audio may be supplied by the video source media.

An advantage of the configuration shown in FIG. **1** is that the video projector **12** need not project an image that fills the entire screen. That is, the video projector **12** may concentrate all of its light output to a more limited area video display subarea **16**. Accordingly, it is believed that projector **12** can acceptably approximate or even exceed the brightness, speed and resolution of film. The video display subarea **16** may be imaged in a fixed location, or may vary in position over time, as described further below.

If a single video projector **12** has insufficient brightness even for the small video display subarea **16** required to be illuminated by its image, multiple video projectors may be used to provide an overlapping composite, brighter image. Alternatively, the light output from each video projector may be used to illuminate smaller areas (which may be adjacent or separated), resulting in a higher perceived brightness for those areas. Plural video projectors may be used, if desired or necessary.

One aspect of the invention is that by simply providing a motion picture in two or more parts, copy protection is improved because a thief would have to steal all components in order to display a complete motion picture. For example, the film version of a motion picture may have a selected portion of each frame (or of periodically or randomly spaced frames) omitted. The omitted portion of the film—a "pro-

tection area"—may be in a regularly-shaped area or an irregularly-shaped area. Examples include a circle or square, or something that looks like television station symbols that are commonly inset into cable television. Conversely, the video projector **12** is provided with a video signal that provides image content for the protection area omitted from the film version of the motion picture. Thus, for example, referring to FIG. **1**, the film version of a motion picture may show an entire motion picture image **14** except for the video display subarea **16**, which may be, for example, an all-black area. Conversely, the video projector **12** provides image information only for the video display subarea **16**. The location of the video display subarea **16**—the protection area—may vary from frame to frame and need not be used in every frame. Accordingly, theft of the film version of the motion picture would mean that pirated copies would have "holes" or black areas in the video content unless the thieves managed to also steal and use the video component of the motion picture. Theft of the video component can be made more difficult by shipping a video version (e.g., a DVD media disk) separately from the film version of the motion picture. Alternatively, theft can be made impossible by providing all or part of a video signal to a motion picture theater from a remote site through a telecommunications link, so that no physical copy of the video component of the motion picture is present in the same distribution channel used for the film version of the motion picture. All or parts of the non-projector apparatus may or may not be shared between multiple projectors and/or theaters, and may be located in projection booths, multi-screen complex offices, local distribution offices, international headquarters, or wherever desired.

In the embodiment of the invention described above, registration of the projected video image with the projected film image must be fairly precise in order avoid annoying artifacts for a legitimate audience. Accordingly, it may be desirable to have the protection area appear in relatively innocuous portions of the projected image, such as in background scenery, shadowed areas, etc., or in scenes where motion obscures such artifacts. Another technique that may be used is to fade both the projected video image near its periphery and the "hole" in the film image near its inner edge, so that registration is not as critical.

If a removable media (e.g., a DVD disk) is used to provide the content for the video projector **12**, it may desirable to tie the removable media to the video media so that the removable media only works with a specific film copy of a motion picture. More generally, each source media instance required for a particular screening, whether video or film, may be formed so as to reside in a subset of such media, each member of such subset being only able to operate with members of a corresponding subset of each other required media. One technique would be to "fingerprint" a pair of film and video media so as to provide a digital "ID" (e.g., a serial number) optically or magnetically encoded on the film media and readable by a suitable transducer, in known fashion. The output ID would then be coupled to the video source **18** where it would be matched with a similar ID encoded into the video media. A match of the IDs would enable the video source **18** to provide a signal to the video projector **12**. Conversely, lack of a match would disable the video projector **12** from projecting a video image, causing the projected film image to be displayed with objectionable protection areas visible. When the audio portion of a motion picture is on a separate media (e.g., DVD), a similar "fingerprinting" technique may be used for copy protection.

In a variant on this embodiment, the video media may be erasable or alterable so that the video source **18** can only play the video media a pre-set number of times. For example, the video media may be a DVD-RAM media which is tied to a signal that indicates playback or use (e.g., a digital signature read from the film media during projection, or simply a "start" command for the playback unit for the media). A count can be kept of the number of times the video media has been played. Upon reaching a pre-set number of counts, the video playback unit would overwrite or otherwise alter the video media to prevent further playback. In a variation of this embodiment, the playback unit may alter or overwrite a video media immediately if the ID from a paired "fingerprinted" film version of the motion picture does not match the signature on the video media, thus preventing use of separately stolen film and video media to project a complete composite motion picture.

In still another variant, only the media copies from corresponding subsets have the information and/or data needed to substantially ensure the ability to produce acceptable and desired motion picture screenings.

FIGS. **2A–2C** are examples of an anti-theft marking system in accordance with the present invention. FIG. **2A** shows a screen **20** upon which is projected a motion picture image from a film projector **10**. Part of the image would comprise an alert message **22** (other elements of the image are not shown, for clarity). The alert message **22** is shown in a "positive" form. FIG. **2B** shows that the video projector **12** projects onto the same screen **20** a matching "negative" version **24** of the alert message **22**. The use of "negative" and "positive" alert messages can be switched or otherwise variously shared between the film version and video version of a motion picture. As used herein, a "positive" image includes the reverse of a "negative" image.

FIG. **2C** shows the composite image seen by the audience. That is, the combination of the "positive" alert message **22** and the matching "negative" alert message **24** form a uniform protection area **26** in which the alert message is not visible. However, if the film version of the motion picture is stolen, the alert message will be perceived by the audience, thereby discouraging black market sales or use of video copies of the motion picture.

In order to avoid the uniform protection area **26** from itself being objectionable, the positive and negative versions of the alert message **22**, **24** can be made small, placed in regions of the background where the blended composite image would be unnoticeable, or more elaborately configured such that the composite pattern can be easily inserted into the background of the film without being distracting to a legitimate audience. For example, "positive" and "negative" images can be "punched out" from an original full color film image, and the missing image information supplied by the video projector **12**, so that when the composite image is "integrated" by the eye, the original image is reconstructed and the protection area becomes unrecognizable or "invisible" on the screen, no matter where positioned. The alert message may also be a symbol or icon which, if visible, would indicate that the original film has been illicitly copied. Variations of this embodiment of the invention provide that the alert message or image be present in every frame; be present periodically; be present randomly; and/or be located at different places in different frames.

In a variation of the embodiment of the invention shown in FIGS. **2A–2C**, the film version of the motion picture may have an alert message while the video projector **12** overlays a non-matching "camouflage" pattern that does not require

high registration and that otherwise obscures the alert message. Thus, as shown in FIG. 2D, an alert message or symbol **30** could be projected on a screen **32** by the film projector **10** onto, for example, an area of background foliage **25**, as shown in FIG. 2D. The video projector **12** may then overlay a non-matching "camouflage" foliage pattern **27** on top of the alert message **30** so as to obscure the alert message during legitimate projection of the motion picture, as shown in FIG. 2E. Again, if the film version of the motion picture is stolen, the alert message or symbol **30** will be perceived by the audience.

In another aspect of the invention, the "positive" alert message **22** and the "negative" alert message **24** need not be projected simultaneously. Film projection is generally at the rate of 24 frames per second. In between frames, a shutter obscures the light source of the film projector **10**. In this embodiment of the invention, the video projector **12** can be used in synchronism with the framing rate of the film projector **10** but exactly out of phase with the "illumination" stage of the film projector **10** shutter. Thus, for example, during the projection of each film frame, the film projector **10** can project the "positive" alert message **22** in a possibly innocuous position on the theater screen. Then, between frames of the film projection, the video projector **12** can project the "negative" alert message **24** so as to be superposed over the position in the previous frame of the "positive" alert message **22**. The human eye will integrate both the negative and positive versions of the alert messages **22**, **24** and perceive only the composite "message-less" (or "unrecognizable" or "invisible") uniform protection area **26**.

This last embodiment has value against surreptitious in-theater filming of a projected film by means of a video or film camera synchronized to the framing rate of the film. Such a camera would only see the "positive" alert message **22**, and not the corresponding "negative" alert message **24**, and thus the "positive" alert message **22** would be perceptible on the illicit copy. Again, the "positive" and "negative" alert messages **22**, **24** need not be shown in every frame and interframe film projection interval; periodic projection or randomly-spaced occasional projection may be sufficient for copy protection purposes. Permitting discretionary display of alert messages also permits easier integration of the composite message into the background of the film so that theater audiences are not distracted by the uniform protection area **26** during legitimate projection of the motion picture.

In a variation of this last embodiment, the film is not altered to include an alert message. Instead, the video projector **12** projects at twice the rate of the film projector **10**, and provides the "positive" alert message **22** in every frame and the "negative" alert message **24** in every interframe film projection interval. Again, the human eye will integrate both the negative and positive versions of the alert messages **22**, **24** and perceive only the composite "message-less" uniform protection area **26**. The "positive" and "negative" (and even three or more parts) images can be projected digitally at any times, even random ones, so long as they are close enough together to be "integrated". This embodiment has value against surreptitious in-theater filming of a projected film by means of a video or film camera synchronized to the framing rate of the film, or which is not capable of (or not used in a way that) lets the camera adequately imitate the integrating (and possibly other) capabilities of the human eye.

In all of the embodiments described above in which an alert message is used, the message may be customized. For example, the alert message can be as particular as "shown in X theater on Y date". The alert message can say things like "CALL XXX-XXXX FOR A REWARD", or "CONTACT XXXX-XXX TO REPORT THIS COPYRIGHT VIOLATION", or "CALL XXX-XXXX FOR FREE GIFT", where the telephone number could be dynamic depending on the screening. A static message about copyright law enforcement could also be used, possibly customized by country. Such time and place "stamping" may be useful in attempting to track down in-theater video thieves by backtracking recovered piratical video tapes to a particular copying source. Alerting audiences to the illegitimacy of the copy/screening and/or providing contact information may also discourage unauthorized copying, transfer, and/or use of the motion picture.

FIGS. **3A** and **3B** are another example of an anti-theft motion picture projection system in accordance with the present invention. FIG. **3A** and **3B** show the use of an alert symbol **30** projected onto a screen **32** and overlaying part of a motion picture element **34**. FIG. **3A** shows that the image from the film projector **10** substantially fills the screen **32**. FIG. **3B** shows that the image from the video projector **12** is focused and aimed by a light director unit **36** to a specific subarea **38** of the screen **32** in order to "hide" (which means camouflage and/or otherwise obscure and/or make unnoticeable and/or make unreadable the alert message) the alert message **30**, as described above. Thus, the video projector **12** need not have sufficient illumination power, contrast, and resolution to provide an acceptable projected image of the motion picture that fills the entire screen **32**. Rather, all of the light output of the video projector **12** is focused on the small subarea **38** of the screen **32**.

The light directing unit **36** is preferably implemented as a steerable mirror and lens system that collects the light output from the video projector **12**, and focuses that light onto the limited subarea **38** of the screen **32**. The location of the subarea **38** on the screen **32** may be varied by angling one or more mirrors **39** within the light directing unit **36**. In a simplistic version of the light directing unit **36**, the mirror **39** is pivoted only in one plane, limiting display of an alert message or symbol to a single "row" or "column" of the screen **32**. However, in a more sophisticated implementation, the mirror **39** may be steerable in two dimensions, allowing the illuminated subarea **38** to be located anywhere on the screen **32**. Suitable actuators for such a mirror are known, and can be, for example, piezoelectric, pneumatic, or electrical actuators or motors. Control for positioning of the mirror **39** may be preset, in which case the alert message will appear in only one position on the screen **32**, or may be synchronized with the film projector **10** or the video projector **12** and cued to the content of the motion picture. Thus, for example, in a first scene, an alert message can be projected in the upper left corner of the screen **32**, while in a second scene, an alert message can be projected in the lower right corner of the screen **32**. Feedback also allows more accurate and sure positioning of the mirror **39**, possibly even varying at the framing rate.

More generally, a media that humans can experience, of whatever type that can be recorded, can be split into two or more recorded parts. The split can be made not only spatially and temporally, as above, and audibly, but also spectrally and/or in terms of polarization and/or tactile information and/or scent information, as examples without limitation, so that all (or a pre-determined kind of majority) of the copy parts must be combined to be likely to create an acceptable experience. The recorded parts can be transported and/or stored separately and/or require different technology and/or equipment and/or knowledge and/or information to render.

Preferably, but optionally, alert messages contained in one or more recorded parts may be effectively canceled for the human senses so as to be unnoticeable and/or unrecognizable and/or invisible when the parts are properly combined. Canceling parts may themselves be alert messages. Commonly available sensor technology may not receive all copy parts accurately from such renderings, and the inaccuracy would preferably be noticeable and/or better yet develop an alert message.

Once installation of the embodiment shown in FIG. 1 is made in various motion picture theaters, the combination may be used for purposes other than the copy protection purposes described above. For example, the video projector 12 may be used to provide special effects for the projected film image. Such special effects may include the use of the video image to enhance the brightness, resolution, or speed of, for example, an animated character or "magic sparkle" that moves around the screen. Dynamics can be exploited, for example, in a horror film, so that the amount of gore displayed may be enhanced by adding imagery using the video projector 12, and the "gorier" version may be displayed for late-night, adult audiences, while the original, less "gory" film version of the motion picture can be shown earlier in the day to younger audiences. Thus, by adding film elements using the video projector 12, a single film can have different ratings.

As another example, if a film scene shows a billboard in the background, the video projector 12 can be used to provide different image content for the billboard, such as advertising which may, for example, show different brands of products at different screenings. As yet another example, a film may be "localized" to a local language by using the video projector 12 to insert text that would appear in a scene (e.g., a street sign or building name) in the local language. As yet another example, the video projector 12 can be used to add elements to some versions of the film that are absent from other versions. For example, in markets where smoking is widely accepted, the video projector 12 may be used to display a pack of cigarettes in a particular scene. In other versions of the film, destined for markets where cigarette smoking is less accepted, the pack of cigarettes may be omitted from the scene. Different versions of audio are also anticipated, with or without different visuals. The capabilities of the invention that allow dynamic insertion of elements permit a number of revenue and profit opportunities of these types.

FIG. 4 is a diagram of yet another embodiment of the invention. In the embodiment illustrated, a film projector 10 and video projector 12 are configured as in FIG. 1 to project a composite image onto a screen 32. Shown on the screen 32 in the illustrated embodiment is a picture element 34. In addition, a camera or other imaging device 40 (preferably of a low-light level type) and/or a microphone 41 are provided in the theater to monitor the audience 42. The camera 40 and microphone 41 may be mounted variously, such as above, in front, or behind the audience 42. The output of the camera 40 and/or microphone 41 is coupled to a computer analysis system 44, the output of which is optionally coupled to the video source 18. More than one camera 40 and/or microphone 41 may be so configured. In a preferred embodiment, the movie soundtrack is electronically canceled from the output of the microphone 41 and/or the camera input is corrected for the projected lighting, in known and/or readily conceivable.

The camera 40 and/or microphone 41 provide an audience monitoring system which can be used to obtain demographic information about the attending audience 42. The system can be used for "manned" monitoring, either locally or remotely, but is preferably used in conjunction with a pattern recognition system to determine a variety of factors or characteristics about the audience 42. For example, the computer analysis system 44 may be used to simply count the number of empty versus full seats in order to verify the number of ticket sales to a particular motion picture. More sophisticated analysis may be used to determine, for example, the adult/child ratio of the audience. This may be determined, for example, by estimating the seated height of each person in the audience, and having an arbitrary threshold height value to separate "children" from "adults", in order to get a first order approximation of the child/adult ratio. Audio feedback from the microphone 41 may be used to determine, for example, the level of laughter or other audible response of the audience 42 to particular scenes in a motion picture.

Pattern recognition algorithms also may be used to distinguish male from female faces in order to determine sex distribution, and "older" from "younger" faces in order to determine age distribution. Other information about the audience may also be determined, such as viewing habits or dynamics (e.g., the amount of time audience members face the screen 32) and/or eating habits or dynamics (e.g., the number audience members holding popcorn boxes, eating popcorn, eating in general, chewing rapidly, or that have stopped chewing). The computer analysis system 44 is preferably a suitably programmed computer, such as a personal computer, capable of implementing any one of the general algorithms described. The computer analysis system 44 may in some embodiments share resources with and/or be combined, in real-time or off-line, and in whole or in part, with other processing sites, including the video source, as already mentioned.

The output of the computer analysis system 44 may be provided to a remote location, such as a central headquarters for a film distributor, for later statistical analysis, or can be used in conjunction with the video source 18 to provide a feedback system coupled to the film projector 10 or video projector 12. Thus, for example, if the computer analysis system 44 can determine the attendance count for the audience 42, that information can be provided to the video source 18 and projected by the video projector 12 some time before, during, or after the projection of the motion picture. As another example, the image taken by the camera 40 may be re-projected through the video projector 12 onto the screen 32 so that the audience 42 may see itself recorded or transmitted, a function that seems to be popular at sporting events.

As another aspect of this embodiment of the invention, the demographic information obtained by the camera 40 and computer analysis system 44 can be used to alter the content displayed by the video projector 12. Thus, for example, if the computer analysis system 44 determines that the audience is predominantly children, the type of special effects displayed during projection of a motion picture can be altered by means of the video projector 12. In general, the video projector 12 can be used to provide or augment images in order to provide variable plot or scene elements depending upon, for example, the demographics of the audience. Also, the film speed and/or intensity and/or color and/or volume and/or sound mix and/or other parameters may be varied responsively.

An authorization scheme may be used with the audience monitoring system shown in FIG. 4 to positively allow a central site to authorize display of a complete motion picture based upon confirmation that the motion picture is being displayed at an authorized site before a legitimate audience. Such authorization may be done on a per screening basis.

As shown in FIG. 4, the video source 18 may be coupled to the film projector 10 by means of a SYNC signal so that the image displayed by the video projector 12 is synchronous with the image projected by the film projector 10. Alternatively, an audiovideo camera 46 may be provided, coupled as shown to the video source 18. The audiovideo camera 46 can be used to "listen to" or "watch" the output of the film projector 10 and provide a signal to the video source 18 from which a SYNC signal can be derived, for example, by pattern matching the sound or projected image against the recorded sound or image on the video image. As an alternative to using a microphone pickup of the theater speakers to generate a SYNC signal, the use of sound to synchronize the video projection with the film projection could be by direct electrical connection into the theater sound system.

An alternative function for the audiovideo camera 46 would be to capture the projected image on the screen 32 and provide that image to a processor within the video source 18. The processor can use the video signal from the audiovideo camera 46 to measure the brightness, color balance, alignment, planarity, focus, etc. of the projected image and adjust the output of the video projector 12. For example, if a protection area projected onto the screen 32 is perceived to be overly bright, a video feedback signal to the video source 18 permits a processor within the video source 18 to determine that such over brightness is occurring, and adjust the output of the video projector 12 accordingly to lower the brightness of the protection area. Similar functions can be utilized to adjust color balance, alignment of the protection area or video camouflage, etc.

The audiovideo camera 46 and the audience monitoring camera 40 may be one device, and either or both may included motorized position control and/or zoom functions. Multiple cameras, with or without audio capabilities, may be used.

A preferred embodiment of the present invention has been described, along with some variations. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, a tamper-resistant chip in the video projector 12 or video source 18 can be used to keep track of the number of showings, the authorization codes, audience statistics, and film IDs. Once apparatus embodying the invention is in place, other uses may be found. For example, while an audience is awaiting presentation of a motion picture, the audience monitoring system may be used in conjunction with dynamic projection of random numbers on a theater screen to operate a bingo-type or lottery-type game. For example, a bingo winner may hold up a hand or card, and the audience monitoring system will zoom in on that person and project an image of the winner and the winning card on the screen for the audience to see. Accordingly, it is to be understood that the invention is not to be limited by the specific illustrated embodiments, but only by the scope of the appended claims.

What is claimed is:

1. A method of displaying a composite image, including:

(a) projecting a first image having at least one portion of the image altered to provide at least one protection area;

(b) projecting separately a second image having image content to obscure each protection area;

wherein the first image and second image form a composite image in which each protection area is essentially hidden from the human eye.

2. The method of claim 1, wherein the composite image further includes a sequence of composite images forming a motion picture.

3. The method of claim 1, including:

(a) providing a monitoring system for gathering information about a motion picture audience and for providing an output signal indicative of at least one selected characteristic of such audience;

(b) applying the output signal to control display characteristics of a motion picture to the audience.

4. The method of claim 3, including applying the output signal to control displayed content of a motion picture to the audience.

5. The method of claim 3, including applying the output signal to display an image of at least a portion of the audience to the audience.

6. A method of monitoring a motion picture audience, including:

(a) providing a monitoring system for gathering information about a motion picture audience and for providing an output signal indicative of at least one selected characteristic of such audience;

(b) applying the output signal to control display characteristics of a motion picture to the audience.

7. The method of claim 6, including applying the output signal to control displayed content of a motion picture to the audience.

8. The method of claim 6, including applying the output signal to display an image of at least a portion of the audience to the audience.

9. A system for displaying a composite image, including:

(a) a first projection device for projecting a first image having at least one portion of the image altered to provide at least one protection area;

(b) a second projection device for projecting separately a second image having image content to obscure each protection area;

wherein the first image and second image form a composite image in which each protection area is essentially hidden from the human eye.

10. The system of claim 9, wherein the composite image further includes a sequence of composite images forming a motion picture.

11. The system of claim 9, further including:

(a) a monitoring system for gathering information about a motion picture audience and for providing an output signal indicative of at least one selected characteristic of such audience;

(b) means for applying the output signal to control display characteristics of a motion picture to the audience.

12. The system of claim 11, wherein the output signal is applied to at least one of the first and second projection devices to control displayed content of a motion picture to the audience.

13. The system of claim 11, wherein the output signal is applied to the second projection device to display an image of at least a portion of the audience to the audience.

14. A system of monitoring a motion picture audience, including:

(a) a monitoring system for gathering information about a motion picture audience and for providing an output

signal indicative of at least one selected characteristic of such audience;

(b) means for applying the output signal to control display characteristics of a motion picture to the audience.

15. The system of claim 14, wherein the output signal is applied to at least one of the first and second projection devices to control displayed content of a motion picture to the audience.

16. The system of claim 14, wherein the output signal is applied to the second projection device to display an image of at least a portion of the audience to the audience.

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